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Species for the Screening Assessment

Columbia River Comprehensive Impact Assessment

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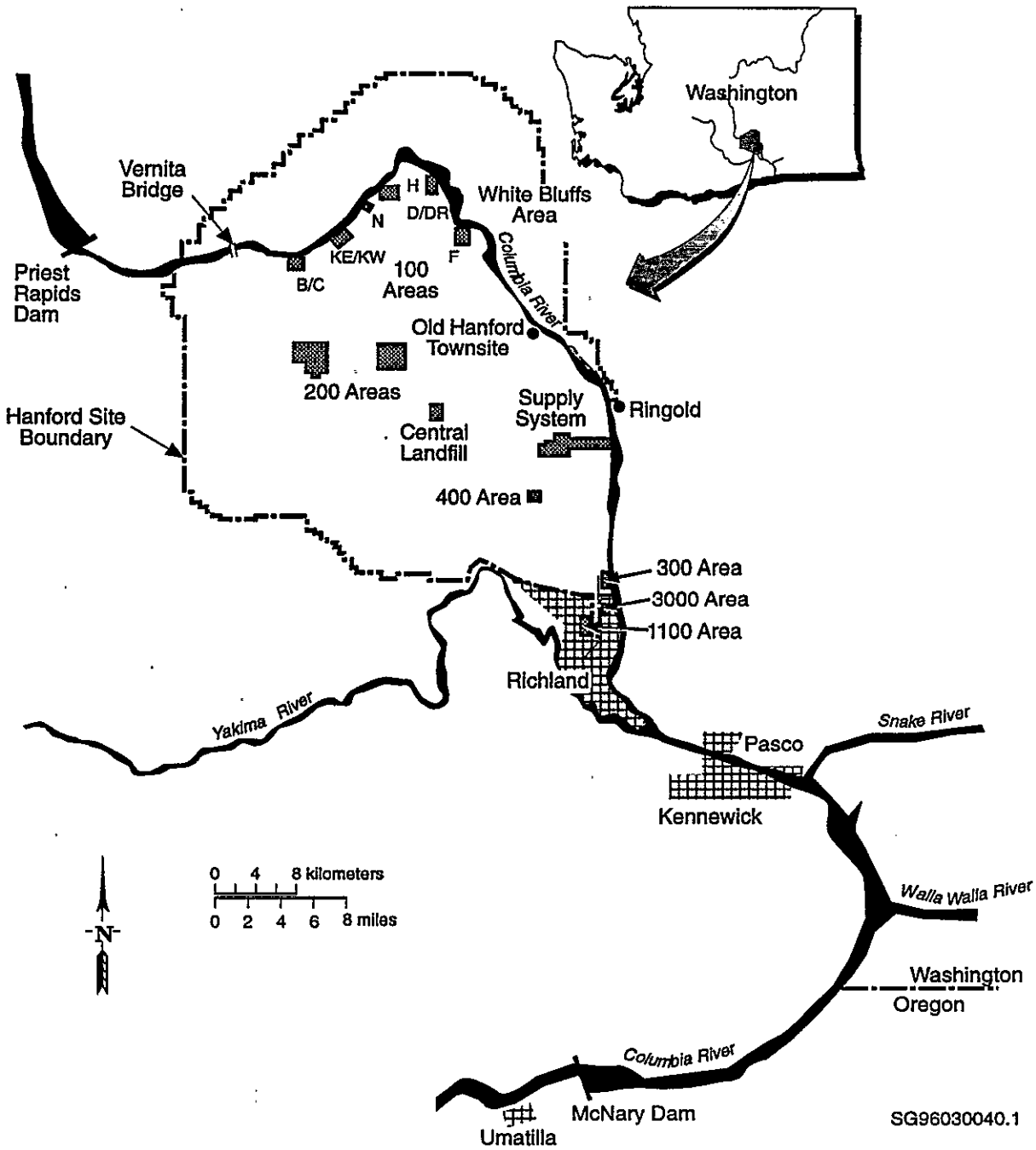

Figure P.1. Map of Hanford Site

Table P.1. Documents in Initial Phase of Columbia River Comprehensive Impact Assessment

Title	Document No.	Publication Date	Status
Data Compendium for the Columbia River Comprehensive Impact Assessment (Eslinger et al. 1994)	PNL-9785	April 1994	Final publication
List of Currently Classified Documents Relative to Hanford Operations and of Potential Use in the Columbia River Comprehensive Impact Assessment January 1, 1973 - June 20, 1994 (Miley and Huesties 1995)	PNL-10459	February 1995	Final publication
Identification of Contaminants of Concern (Napier et al. 1995)	PNL-10400	January 1995	Published as a draft - Issued first in January 1995 for review, then again in January 1996; comments from both review periods will be addressed and report will be a section in the *Screening Assessment and Requirements for a Comprehensive Assessment* report
Human Scenarios for the Screening Assessment (Napier et al. 1996)	DOE/RL-96-16-a Rev. 0	March 1996	Published as a draft - Then comments will be addressed and report will be a section in the *Screening Assessment and Requirements for a Comprehensive Assessment* report
***Species for the Screening Assessment* (Becker et al. 1996)**	**DOE/RL-96-16-b Rev. 0**	**March 1996**	**Published as a draft - Then comments will be addressed and report will be a section in the *Screening Assessment and Requirements for a Comprehensive Assessment* report**
Data for the Screening Assessment	DOE/RL-96-16-c Rev. 0	April 1996	To be published as a draft - Then comments will be addressed and report will be a section in the *Screening Assessment and Requirements for a Comprehensive Assessment* report
Columbia River Comprehensive Impact Assessment: Screening Assessment and Requirements for a Comprehensive Assessment	DOE/RL-96-16 Rev. 0	July 1996	To be published as a draft - Will incorporate all previous draft publications (not those published as final) plus sections on site characterization, screening assessment of risk, and CRCIA Team statement of work to be done after the initial phase
Columbia River Comprehensive Impact Assessment: Screening Assessment and Requirements for a Comprehensive Assessment	DOE/RL-96-16 Rev. 1	October 1996	To be published final - Will incorporate responses to comments and minority opinions should any comments not be reconciled

Preface

The protection of the Columbia River is of special interest to the public, government, and tribal governments as a source of drinking water, for crop irrigation, as ecological habitat, for recreation, and as a cultural resource. Because of past nuclear production operations along the Columbia River, there is intense public and tribal interest in assessing any residual Hanford Site related contamination along the river from the Hanford Reach to the Pacific Ocean. The Columbia River Comprehensive Impact Assessment was proposed to address these concerns.

Background

From 1944-1987, the U.S. Department of Energy (DOE) conducted nuclear production operations along the Hanford Reach of the Columbia River (see Figure P.1). The Hanford Reach extends 85 kilometers (51 miles) downstream from Priest Rapids Dam to the head of the McNary Pool near the city of Richland, Washington. These past nuclear operations resulted in the release of hazardous chemicals and radionuclides to the Columbia River. Current conditions of the Columbia River reflect that contamination is reaching the river primarily via the groundwater pathway. Seeps, an extension of groundwater flow, and biota also contribute to the Hanford-origin contamination present in the river.

The area where the nuclear materials were produced is known as the Hanford Site. Four areas of the Hanford Site (the 100, 200, 300, and 1100 Areas) have been placed by the U.S. Environmental Protection Agency (EPA) on the national priorities list for cleanup. The national priorities list is a component of the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) (42 USC 9601) enacted by the U.S. Congress.

The cleanup of the Hanford Site is a joint activity of three government agencies: DOE, EPA, and the Washington State Department of Ecology. These Tri-Party agencies have signed an agreement known officially as the *Hanford Federal Facility Agreement and Consent Order* and unofficially as the Tri-Party Agreement (Ecology et al. 1994). Milestones have been adopted for the Tri-Party Agreement that identify actions needed to ensure acceptable progress toward Hanford Site compliance with CERCLA, the *Resource Conservation and Recovery Act of 1976* (42 USC 6901), and the *Washington State Hazardous Waste Management Act* (RCW 1985).

During 1993, the Tri-Party agencies began work toward a comprehensive assessment of the impact of past nuclear operations on the current conditions of the Columbia River (DOE 1994). In January 1994, a revision to the Tri-Party Agreement (Change Order number M-13-93-06) adjusted the milestones designed to address cleanup strategies and achieve timely remedial decisions and actions concerning the Columbia River. This change order included a new Milestone, M-15-80 (formerly M-13-80b), that established the Columbia River Comprehensive Impact Assessment (CRCIA). In December 1995, a follow-on change order (M-15-95-09) modified the milestone, enhancing the review process and specifying target dates.

CRCIA Long-Term and Short-Term Objectives

Because the scope and priorities of CRCIA have been controversial, the Columbia River Comprehensive Impact Assessment Management Team (CRCIA Team) was formed in August 1995 to advise the Tri-Party agencies. The CRCIA Team meets weekly to share information and provide input to decisions made by the Tri-Party agencies concerning CRCIA. Representatives from the Confederated Tribes of the Umatilla Indian Reservation, Hanford Advisory Board, Nez Perce Tribe, Oregon State Department of Energy, and Yakama Indian Nation have been active participants on the team. The specific goals of the CRCIA Team are:

- provide recommendations on the CRCIA work being conducted by the Pacific Northwest National Laboratory
- provide recommendations on future work necessary for the assessment to be comprehensive
- represent public, tribal, and affected government interests
- act as an information resource for future decisions on remedial measures

The long-term objective of CRCIA (according to the CRCIA "Project Management Team Charter," dated October 1995) is to focus on the current impact of Hanford Site activities on the Columbia River and the resulting impact on human health and the environment. The comprehensive assessment will evaluate the extent of any resulting contamination and determine the current human and ecological risk from the Columbia River attributable to past and present activities at the Hanford Site. Human risk from exposure to radioactive and hazardous materials will be addressed for a range of river use options. Ecological resources in the study area will be evaluated to determine if current contaminant conditions pose significant hazards to biological communities. Information collected will be used in remedial action decisions for the Hanford Site.

The assessment of the Columbia River is being conducted in phases. The initial phase is a screening assessment of risk, which addresses current environmental conditions for a range of potential uses. Specifically, the short-term objectives of the work in this initial phase (according to an agreement signed by the CRCIA Team, dated October 1995) are:

1. Perform an assessment of contaminants derived from the Hanford Site (existing conditions including residual contaminants from past operations) in a screening assessment of risk to support the Interim Remedial Measures decisions
2. Compile and make available to the public the approximately 2000 documents identified in Appendix A of the data compendium (Eslinger et al. 1994); pertinent supporting Hanford Site data will be made available
3. Work with the declassification efforts of the Hanford Advisory Board to identify the Columbia River documents as a high priority for release

4. Define the essential work remaining to provide an acceptable comprehensive river impact assessment; this work will be documented in the same report as the screening assessment of risk

5. Provide data from numbers 2 and 3 above for reconciliation against the risk assessment

The Tri-Party agencies are conducting CRCIA. The primary contractor for the initial phase of the CRCIA work is the Pacific Northwest National Laboratory. Bechtel Hanford, Inc. provides technical and public involvement coordination with environmental restoration activities. Technical peer reviewers are evaluating the work. Their review comments are compiled by the Directors of the Oregon Water Resources Research Institute and State of Washington Water Research Center and forwarded to DOE for resolution.

Scope of the Initial Phase of CRCIA

The scope of the initial phase of CRCIA is to provide a screening assessment of the current risk to humans and the environment resulting from Hanford-derived contaminants. For the initial phase of CRCIA, the segment of the Columbia River from Priest Rapids Dam (first impoundment upstream of the Hanford Site) to McNary Dam (first impoundment downstream of the Hanford Site) was selected as the study area. The parameters of the scope are:

Area:	Columbia River (Priest Rapids Dam to McNary Dam), groundwater (0.8 kilometer/0.5 mile in from the river), and adjacent riparian zone
Time:	January 1990 - February 1996 (date data were received for use in the screening assessment) with data gaps filled by earlier data where available
Contaminants:	Published in Napier et al. (1995)
Receptor Species:	Published in this report
Media:	Surface water, sediment, groundwater, external radiation, seeps and springs, biota

Work Integration and Documentation

The results of the initial phase of CRCIA are being reported in a series of documents (see Table P.1). These reports reflect the process involved in the screening assessment of risk. First the documents containing pertinent data were identified. That information was published in two reports (Eslinger et al. 1994 and Miley and Huesties 1995), which were issued as final documents.

These data documents helped to identify Hanford Site contaminants that affect the Columbia River. The winnowing process used to determine which of those contaminants should be evaluated in the screening assessment of risk was published in Napier et al. (1995) as a draft. The comments on the draft are being incorporated, and the contaminants information will appear as a section in the draft of the report on the screening assessment and requirements for a comprehensive assessment.

Next, potential groups of people with different exposures to the Columbia River were identified. With information from the Hanford Site Risk Assessment Methodology (DOE 1995) and with input from the CRCIA Team, scenarios were written defining the pathways and exposures for the various groups. Input from the scenarios will be used in the screening assessment of human risk. The scenarios are described in Napier et al. (1996).

Simultaneously, a focusing process was used to identify the receptor species and select those to be evaluated in the screening assessment of ecological risk. The focusing process and the results are provided in this report.

The monitoring data available, the lists of contaminants and species to be evaluated, and the selection rules developed by the CRCIA Team determined which data were selected for use in the screening assessment of human and ecological risk.

As with the contaminants report, the scenarios, receptor species, and data selection reports are being published first as drafts for review. The reports published first as drafts will be compiled into one document on the screening assessment and requirements for a comprehensive assessment. That document will provide the results of the screening assessment and a definition of the essential work remaining to provide an acceptable comprehensive river impact assessment.

Summary

Because of past nuclear production operations along the Columbia River, there is intense public and tribal interest in assessing any residual Hanford Site related contamination along the river from the Hanford Reach to the Pacific Ocean. The Columbia River Comprehensive Impact Assessment was proposed to address these concerns. The assessment of the Columbia River is being conducted in phases. The initial phase is a screening assessment of risk, which addresses current environmental conditions for a range of potential uses.

One component of the screening assessment estimates the risk from contaminants in the Columbia River to the environment. The objective of the ecological risk assessment is to determine whether contaminants from the Columbia River pose a significant threat to selected receptor species that exist in the river and riparian communities of the study area. This report 1) identifies the receptor species selected for the screening assessment of ecological risk and 2) describes the selection process. The screening assessment of ecological risk will be reported in a later document.

The species selection process consisted of two tiers. In Tier I, a master species list was developed that included many plant and animal species known to occur in the aquatic and riparian systems of the Columbia River between Priest Rapids Dam and the Columbia River estuary. This master list was reduced to 368 species that occur in the study area (Priest Rapids Dam to McNary Dam). A panel of regional biologists from federal and state resource management agencies developed a set of six criteria that were applied to each of the study area species. Ninety-three study area species were identified using these six criteria. The Columbia River Comprehensive Impact Assessment Management Team (CRCIA Team) added an additional 88 species to these 93 to create a list of 181 Tier I species.

In Tier II, the 181 Tier I species were qualitatively ranked based on a scoring of their potential exposure and sensitivity to contaminants using a conceptual exposure model for the study area. In this model, species were scored based on 1) potential dietary exposure to biomagnifying and non-biomagnifying contaminants, 2) potential dermal and inhalation exposure to contaminants, 3) potential exposure to contaminated media weighted to reflect their relative importance at the two types of source areas (outfall and in-river), 4) exposure duration, and 5) sensitivity to contaminants. The CRCIA Team identified 65 of the 181 species as tentative Tier II receptor species based on their rank and ecological importance. These 65 were further reduced to 43 final Tier II receptor species by excluding those with the lowest rank, those that virtually never use the river and riparian areas, and those within the same foraging guild that have the largest body weight (Table S.1). These 43 Tier II receptor species are those for which contaminant exposures and effects will be analyzed in the screening assessment of ecological risk, which will be reported in a later document.

Table S.1. Tier II Receptor Species

Taxa/Species*	Rank Based on Grand Average Exposure Scores	Rank Based on Composite Effect Scores	Selected by CRCIA Team as Tentative Tier II Receptor Species	Final Tier II Receptor Species
Algae				
Periphyton	1	1	*	+
Amphibians				
Bullfrog	1	1	*	+
Spadefoot toad	2	1	*	(b)
Woodhouse's toad	2	1	*	(b)
Aquatic Invertebrates				
Caddisfly	1	1	*	(b)
Crayfish	1	1	*	+
Fresh water shrimp	1	1	*	+
Mayfly	1	1	*	+
Midge	1	1	*	(b)
Clams/mussels/Snails	1	1	*	+
Water flea	10	10	*	+
Birds				
American coot	1	1	*	+
Common snipe	3	2	*	+
Diving ducks (e.g., bufflehead)	7	20	*	+
Goose/Mallard	8	5	*	+
Great blue heron	8	5	*	+
American white pelican	11	7	*	+
Common merganser	11	21	*	(b)
Forster's tern	11	21	*	+
Pied-billed grebe	11	7	*	(b)
California quail	17	11	*	+
Red-winged blackbird	17	23	*	(b)
Cliff swallow	21	25	*	+
Belted kingfisher	22	26	*	(b)
Osprey	22	26	*	(b)
Bald eagle	24	28	*	+
Northern harrier	26	13	*	+
American kestrel	29	16	*	+
Barn owl	29	16	*	(c)
Emergent Vegetation				
Columbia yellowcress	1	1	*	+
Common cattail	1	1	*	(b)
Rush (all)	1	1	*	+
Fish				
Channel catfish	1	1	*	+
Largescale sucker	2	2	*	+
Mountain sucker	2	2	*	+
Paiute sculpin	4	4	*	(b)
Carp	6	6	*	+
Mountain whitefish	6	6	*	+

Table S.1. (contd)

Taxa/Species*	Rank Based on Grand Average Exposure Scores	Rank Based on Composite Effect Scores	Selected by CRCIA Team as Tentative Tier II Receptor Species	Final Tier II Receptor Species
White sturgeon	6	6	*	+
Pacific lamprey	9	16	*	+
Shiner	9	9	*	(b)
Salmon (all)	12	17	*	+
Squawfish	12	11	*	(c)
Trout (bull and rainbow)	12	11	*	(b)
Steelhead	18	18	*	+
Fungi	1	1	*	+
Macrophytes				
Water milfoil	1	1	*	(b)
Duckweed	3	3	*	(b)
Mammals				
Muskrat	1	1	*	+
Beaver	3	3	*	+
Coyote	3	3	*	(b)
Raccoon	3	3	*	+
Mule deer	7	7	*	(b)
Great Basin pocket mouse	8	8	*	(a)
Weasel	8	8	*	+
Western harvest mouse	8	8	*	+
Reptiles				
Western garter snake	1	1	*	+
Terrestrial Vegetation				
Black cottonwood	1	1	*	+
Columbia milk vetch	1	1	*	(a)
Dense sedge	1	1	*	+
Fern	1	1	*	+
Mulberry	1	1	*	+
Reed canarygrass	1	1	*	+
Rushes	1	1	*	+
Willow (all)	1	1	*	(b)

* Terrestrial invertebrates are not included in this table because no species in this taxon were selected by the CRCIA Team as tentative Tier II receptor species.
\+ One of the 43 Tier II receptor species
a. Species that virtually never occur in the river or riparian zone
b. Species with a life style similar to that of another Tier II receptor species
c. Species with low grand average exposure scores

Glossary

100 Areas	sites of the Hanford production reactors, which include B, C, D, DR, F, H, KE, KW, and N Reactors
200 Areas	sites of the Hanford chemical separations plants, which include the bismuth phosphate process plants (B and T Plants), plutonium uranium extraction plant (A Plant/PUREX), and reduction and oxidation plants (S Plant/REDOX)
300 Area	site of the research, development and fuel-fabrication operations
1100 Area	site of the warehouse, vehicle maintenance, and transportation operations center
abiotic	non-living or not derived from living material
biomagnifying	having a tendency to occur in higher concentrations at higher food chain levels through dietary accumulation
biota	plants and animals
biotic	referring to animals, plants, or their products
carnivore	organism that feeds on animals
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
concentration	amount of a specified substance(for example, a radioactive element) in a unit amount of another substance (for example, river water, milk)
conceptual model	a generic representation of a process or entity generalized from particular instances
CRCIA	Columbia River Comprehensive Impact Assessment
CRCIA Team	Columbia River Comprehensive Impact Assessment Management Team
DOE	U.S. Department of Energy
Ecology	Washington State Department of Ecology

EPA	U.S. Environmental Protection Agency
exposure	the process by which the temporally and spatially distributed concentrations of a chemical in the environment are converted to a dose
foraging guild	broad group of organisms that have a similar composition; examples include carnivore and omnivore
Hanford Reach	segment of the Columbia River that extends 85 kilometers (51 miles) downstream from Priest Rapids Dam to the head of the McNary Pool near the city of Richland, Washington
hazardous (chemicals)	having the property of being toxic at some level of exposure; generally used to differentiate from carcinogenic
herbivore	organism that feeds on plants
model	a representation of a process or entity; the representation may be graphical or a set of mathematical equations that simulate the process or entity being modeled; see also conceptual model
non-biomagnifying	having a tendency to decrease in concentration at higher levels in the food chain
omnivore	organism that feeds on both plants and animals
piscivore	organism that feeds on fish
PNNL	Pacific Northwest National Laboratory
production operations	activities connected with the production reactors (B, C, D, DR, F, H, KE, KW, or N reactors) in which uranium or other fuel was irradiated with neutrons to produce radioactive materials; used primarily at Hanford to produce plutonium for weapons; used also for research
radionuclide	radioactive isotope of an element
RCRA	*Resource Conservation and Recovery Act of 1976*
reactor	see production operations
receptor species	species to be evaluated for contaminant exposures and effects

release	discharge of a substance into the environment
risk assessment	estimation of the severity and likelihood of harm to human health or the environment occurring from exposure to a particular substance or activity
screening assessment of risk	risk assessment with limited scope; for example, the initial phase of CRCIA is a screening assessment of risk because it is restricted to 1) current conditions, 2) the area between Priest Rapids Dam and McNary Dam, 3) a limited number of contaminants, 4) a few selected receptor species, and 5) a limited amount of monitoring data; the objective of the screening assessment of risk is to identify areas where significant potential exists for adverse effects
seeps	locations where groundwater oozes to the surface
sensitivity	susceptibility of an organism to adverse effects resulting from exposure to contaminants
sensitivity analysis	determination of the parameters and pathways that contribute most to the uncertainty in exposure or effects calculations
sink	medium in which contaminants are deposited and from which there is little or no contaminant migration (for example, sediments immediately upstream from McNary Dam)
source	medium from which contaminants migrate into the surrounding environment (for example, seeps and springs in the riparian area of the Columbia River)
source term	amount of radioactivity (curies) of a radionuclide or amount of a chemical released to the environment at a given time
springs	source of water issuing from the ground
toxicological benchmark	quantitative summary of the results of a toxicity test
TPA	Tri-Party Agreement (officially, *Hanford Federal Facility Agreement and Consent Order*)
uncertainty	a measure of variability in model parameters or dose estimates

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1.0 Introduction

One component of the initial phase of the Columbia River Comprehensive Impact Assessment (CRCIA) is a screening assessment of risk to the environment. The objective of the ecological risk assessment is to determine whether Hanford derived contaminants from the Columbia River pose a significant threat to selected receptor species that exist in the river and riparian communities of the study area. This report 1) identifies the receptor species selected for the screening assessment of ecological risk and 2) describes the selection process. The screening assessment of ecological risk will be reported in a later document.

The Columbia River is a complex ecosystem consisting of numerous species. Once contaminants have entered into the riparian or aquatic communities, all species in the relevant food webs (Figures 1.1 and 1.2) may be considered potential receptors. For the purposes of the screening assessment of risk to the environment, the number of species to be evaluated were reduced to those that have a high potential for exposure to contaminants and that are important to the Columbia River Comprehensive Impact Assessment Management Team (CRCIA Team). This document describes the two-tier screening approach used to select the receptor species for this risk assessment.

The CRCIA assessment of risk to the environment is a screening study because it 1) is limited in its spatial and temporal scope and in the number of receptor species it evaluates and 2) addresses only the issue of whether contaminants exceed levels that harm identified receptor species. It will not attempt to address the average hazard of contaminants because this would require significantly more information on the temporal and spatial fluxes of contaminants and distributions of species than the scope of the screening assessment will allow. Instead, this risk assessment will evaluate direct effects to receptor species, in other words, those caused by exposure to contaminants. Indirect effects (for example, repercussions in the food chain that may result from direct effects to receptor species) at the population and community levels will be addressed if and where direct effects are found to be significant. The results of this risk assessment will serve to focus a subsequent and more comprehensive risk assessment which will likely evaluate 1) a larger segment of the Columbia River, 2) hazards posed by past and present contaminant fluxes, and 3) a larger number of receptor species.

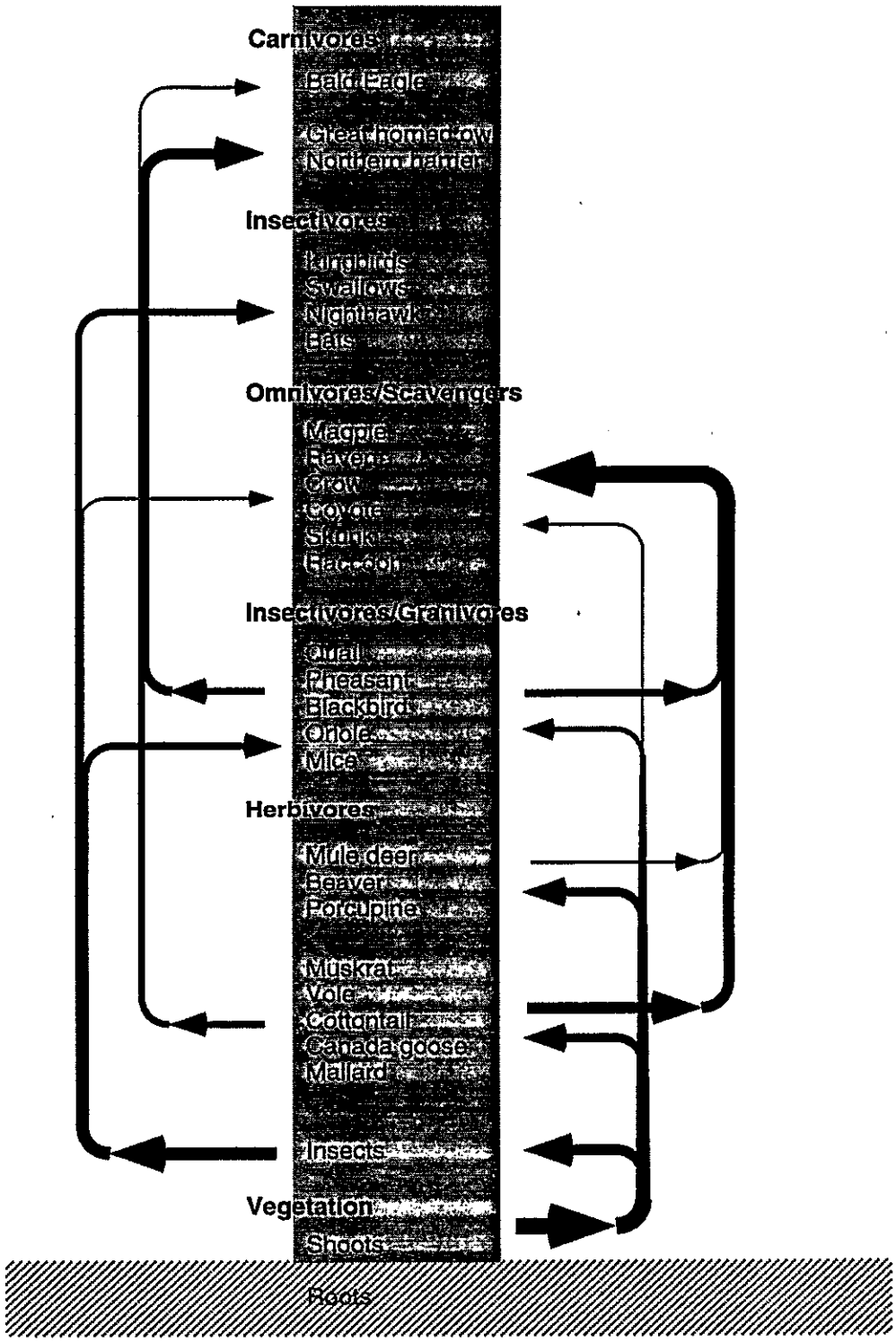

Figure 1.1. Riparian Food Web for the Screening Assessment of Ecological Risk from the Columbia River

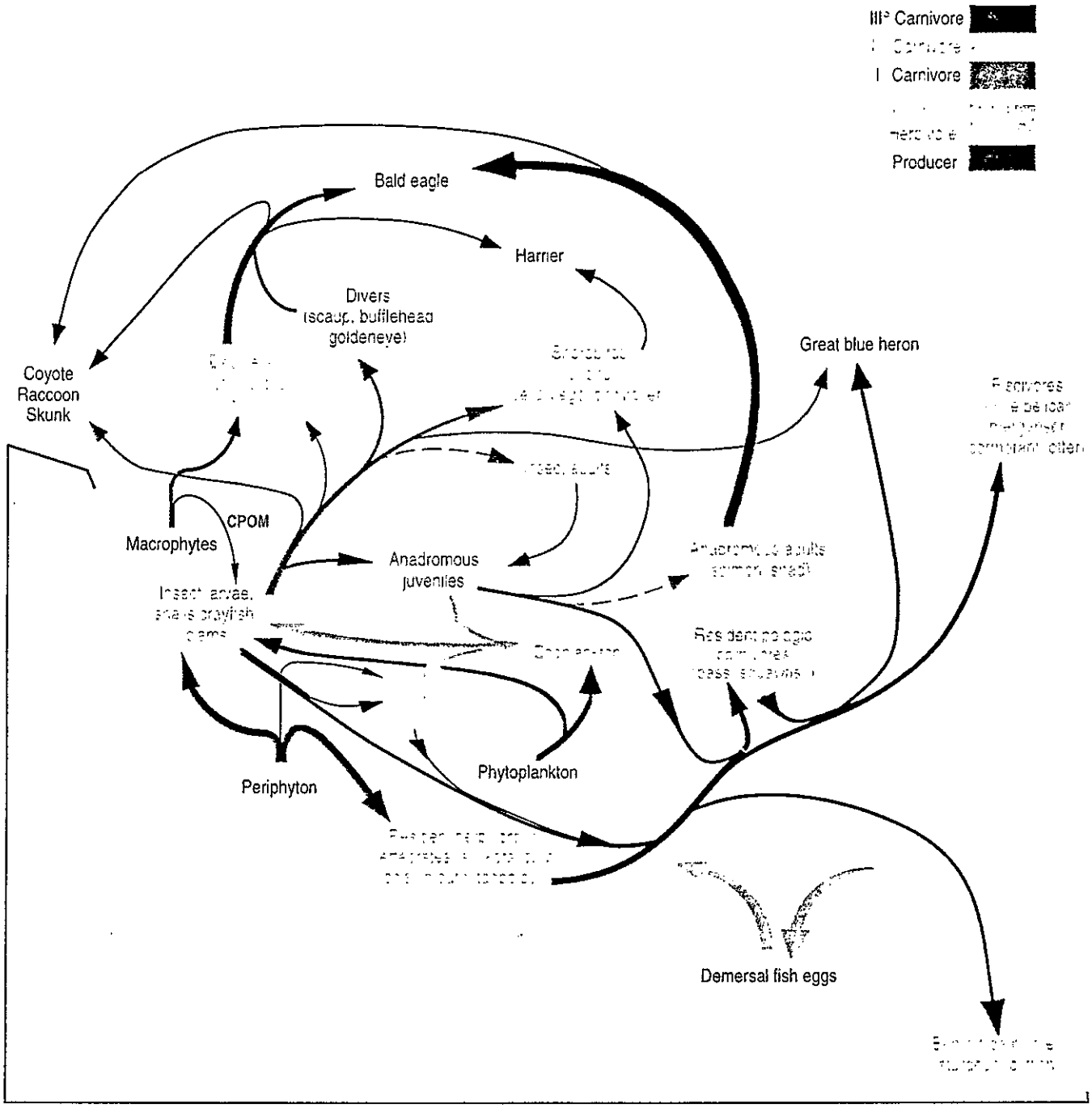

Figure 1.2. Aquatic Food Web for the Screening Assessment of Ecological Risk from the Columbia River

2.0 Ecosystem

The portion of the river within the study area (Priest Rapids Dam to McNary Dam) lies within the lower Columbia River Basin, which is a part of the western intermountain sagebrush steppe ecosystem (West 1988). The ecology of the aquatic and riparian systems within the study area has been studied extensively in the last 50 years, largely because of concerns about hydropower and reactor construction and operation. Major summaries of biological studies conducted in association with Hanford Site operations include Becker (1990) and Cushing (1994). Studies specific to biological resources of the river and riparian areas at the Hanford Site include Weiss and Mitchell (1992) and Landeen et al. (1993) for the 100 Areas and Brandt et al. (1993) for the 300 Area. Studies relating to the Washington Public Power Supply System reactors at the Hanford Site are summarized in Page et al. (1982). Studies in support of the proposed U.S. Army Corps of Engineers Ben Franklin Dam are summarized in Fickeisen et al. (1980). These documents will not be reviewed in this report. The reader is referred to the above sources for detailed discussions of the Hanford Reach and its biological resources. Key points of the riparian and aquatic systems under study are provided below. Common names are used in the following description. Appendix A provides the Latin nomenclature.

The Hanford Reach comprises the last unimpounded portion of the Columbia River in the United States above Bonneville Dam. It supports diverse plant, fish, and wildlife species that are locally abundant. Food webs that pictorially display the foraging interrelationships of species of the riparian and aquatic systems in the study area are presented in Figures 1.1 and 1.2, respectively.

2.1 Riparian Community

The dominant riparian vegetation includes black cottonwood, bulrushes, cattail, reed canarygrass, white mulberry, willows, and numerous species of sedges and forbs. The riparian zone of the study area is known to include four plants on federal and/or Washington State protected species lists (Sackschewsky et al. 1992, WNHP 1994). These are Columbia yellowcress (state endangered, federal candidate), dense sedge (state sensitive), false pimpernel (state sensitive), and southern mudwort (state sensitive).

Fitzner and Gray (1991) listed 39 species of mammals known to occur on the Hanford Site. Brandt et al. (1993) identified 24 as occurring within the riparian zone of the Columbia River. Principal herbivorous species include beaver, deer mice, mule deer, and muskrats. Insectivorous species include several species of Myotis bats that forage primarily on emergent insects, and the northern grasshopper mouse and vagrant shrew that forage primarily on terrestrial insects and other arthropods. Omnivores include coyote, raccoon, and striped skunk. Predators include bobcat, mink, otter, and weasels. Five bat species that occur or potentially occur in the study area are listed as federal candidates under the Endangered Species Act (50 CFR 58982). Two other bats (the pallid bat and long-eared myotis bat) and the northern grasshopper mouse are listed as monitor species by Washington State (WDW 1994).

Weiss and Mitchell (1992) identified 103 bird species associated with the riparian community of the Hanford Reach. These include species that use the area only during winter (for example, American

widgeon, bald eagle), only during summer (for example, cliff swallow, Forster's tern,), or year-round (for example, barn owl, mallard). Principal herbivorous species include Canada geese and mallards. Principal omnivorous species include black-billed magpie, California quail, crow, the dabbling ducks (for example pintail and teal), raven, and ring-necked pheasant. Carnivores and insectivores comprise the bulk of the avifauna, which includes species such as bald eagle, belted kingfisher, black-crowned night heron, great blue heron, gulls, hawks, owls, shorebirds, swallows, and terns. Two birds, Aleutian Canada goose and bald eagle, are listed as threatened under the Endangered Species Act. Three birds, black tern, ferruginous hawk, and little willow flycatcher, are listed as candidates under the Endangered Species Act (50 CFR 58982). Aleutian Canada goose, American white pelican, bald eagle, ferruginous hawk, and sandhill crane, are listed as either threatened or endangered by Washington State. Common loons are candidates for listing by Washington State (WDW 1994).

Amphibians in the study area include the bullfrog, Great Basin spadefoot, Pacific tree frog, and Woodhouse's toad (Brandt et al. 1993). None are abundant within the region. However, all use backwater areas of the Columbia River to complete their life cycles. Woodhouse's toad is listed as a monitor species by Washington State (WDW 1994).

Principal reptiles in the riparian zone include the gopher snake, painted turtle, side-blotched lizard, western garter snake, and western yellow-bellied racer (Fitzner and Gray 1991). The turtles are more often associated with ponds than the river but may be present in the sloughs where water velocities are low. None of the reptile species associated with the riparian zone are listed for protection by state or federal agencies.

2.2 Aquatic Community

Aquatic vegetation is comprised of three general taxonomic groups: phytoplankton, periphyton, and macrophytes. Semi-aquatic or emergent vegetation, although generally rooted in standing water, is considered within the riparian vegetation described above. Diatoms dominate the Columbia River algae, comprising more than 90 percent of the biomass. The primary genera include *Asterionella*, *Cyclotella*, *Fragillaria*, *Melosira*, *Stephanodiscus*, and *Synedra* (Neitzel et al. 1982a, Brandt et al. 1993). The peak of phytoplankton abundance is in April and May with a secondary peak in late summer and early autumn. Periphyton develops on suitable substrate where light is sufficient for photosynthesis. Diatoms also predominate among this group. Macrophytes are sparse outside of McNary Pool and slack water areas because they require relatively low flow and a sediment substrate in which to root. Common species include curled leaf pondweed, duckweed, and water milfoil. Where present, macrophytes provide food and shelter for juvenile fish and spawning substrate for some species of fish.

Zooplankton are generally sparse in the study area (Neitzel et al. 1982b, Brandt et al. 1993). Dominant genera are *Bosmina*, *Cyclops*, *Diaptomus*. Densities are lowest during winter and highest during summer.

Benthic invertebrates (invertebrate species associated with the substrate rather than the water column) include all major fresh water benthic taxa (Brandt et al. 1993). The invertebrate fauna is dominated by insect larvae, particularly black flies, caddis flies, and midge flies. Other benthic organisms include crayfish, limpets, snails, and sponges. Larval insect densities peak during late fall and winter with peak

emergence occurring during spring and summer. Benthic invertebrates are important food items for nearly all juvenile and adult fish in the study area. Two molluscs, the California floater and Columbia pebblesnail, are listed as candidates for protection under the Endangered Species Act (50 CFR 58982). The pebblesnail and shortface lanx (another mollusc) are Washington State candidate species (WDW 1994).

A total of 44 species of fish are known to occur in the Hanford Reach (Gray and Dauble 1977, Cushing 1994). Chinook, coho, and sockeye salmon and steelhead trout use the Reach as a migration corridor to and from upstream spawning areas. The Hanford Reach supports the only major spawning habitat for the upriver bright race of fall chinook salmon within the main stem of the Columbia River (Dauble and Watson 1990). American shad (Cushing 1994) and steelhead trout (Gray and Dauble 1977) may also spawn within the study area. Of the fish species known to occur within the study area, two (bull trout and river lamprey) are candidates for listing under the Endangered Species Act (50 CFR 58982). However, collection of these two species has been rare (Gray and Dauble 1977). Four others (mountain sucker, Piute sculpin, reticulate sculpin, and sand roller) are listed as monitor species by Washington State (WDW 1994).

3.0 Screening Approach

To identify the receptor species that have a high potential for exposure to contaminants and that are important to the CRCIA Team, a two-tier screening approach was used (Figure 3.1).

3.1 Tier I Receptor Species Screen

A list of Tier I receptor species was identified using the following protocol. A master species list was developed that included plant and animal species known to occur in riparian and aquatic systems of the Columbia River between Priest Rapids Dam and the Columbia River estuary. This master list was reduced to 368 species that occur within the study area. A panel of regional biologists developed a set of six criteria that were applied to each of the study area species. Ninety-three study area species were identified based on the scoring results of these six criteria. An additional 88 species provided by the CRCIA Team were added to these 93 to create a list of 181 Tier I species.

3.1.1 Master Species List

A master species list was assembled that included terrestrial and aquatic plant and animal species known to occur in riverine and riparian habitats of the Columbia River between Priest Rapids Dam and the Columbia River estuary. The master list was developed by selecting species from databases and records maintained by the following federal and state resource management agencies associated with the Columbia River and its environs:

Bonneville Power Administration, Northwest Environmental Database
Oregon Department of Environmental Quality, Columbia River Bi-State Program
Oregon Department of Fish and Wildlife, Wildlife Diversity Plan
Oregon Natural Heritage Program
Pacific States Marine Fisheries Commission, Coordinated Information System
U.S. Fish and Wildlife Service, Black Water Island Research Area
U.S. Fish and Wildlife Service, McNary National Wildlife Refuge
U.S. Fish and Wildlife Service, Ridgefield National Wildlife Refuge
U.S. Fish and Wildlife Service, Umatilla National Wildlife Refuge
U.S. Fish and Wildlife Service, Willapa National Wildlife Refuge
Washington Department of Fish and Wildlife, Priority Habitats Database
Washington Department of Natural Resources Natural Heritage Program
Washington State Energy Office, Pacific Northwest Rivers Study

Species distributions and habitat preferences were also obtained from these agencies. The preponderance of information was from the U.S. Fish and Wildlife Service national wildlife refuges (Figure 3.2). Information on species distributions and habitat preferences was used to exclude species that primarily use upland areas. From the resulting master species list, 368 species were identified as those that occur within the study area (Appendix A).

List Name	Content of List	Agency Screening Protocol Criteria for Listing	No. of Species in List
Tier I	Species in the study area (all species considered to be potential receptors)	• Riparian and/or aquatic species	368
		...s by panel of regional biologists *...highest-scoring species from panel screening* *...additional key species by CRCIA Team*	
	Species identified for further consideration in this screening of potential receptor species	• ...mmercial or recreational importance • Legal protection status • Key predator or prey species • High potential exposure to contaminants • Available toxicological benchmarks • Representative of a foraging guild • Significant cultural importance (CRCIA Team criterion)	181
		...anking of Tier I species based on potential exposure to ...minants *...A Team selection of tentative Tier II receptor species ... necessarily the highest ranked)* *...NL selection and CRCIA approval of final Tier II receptor species*	
Tier II	Receptor species to be analyzed for contaminant exposure and effects in the ecological risk assessment	• High potential exposure to contaminants (i.e., highly ranked) • High concern from a cultural/resource management perspective (CRCIA Team criterion) • Representatives of most major taxa included • Species within taxonomic groups that have a relatively small body weight	43

Figure 3.1. Selection Process and Criteria Used to Identify Receptor Species for the Screening Assessment of Ecological Risk from the Columbia River

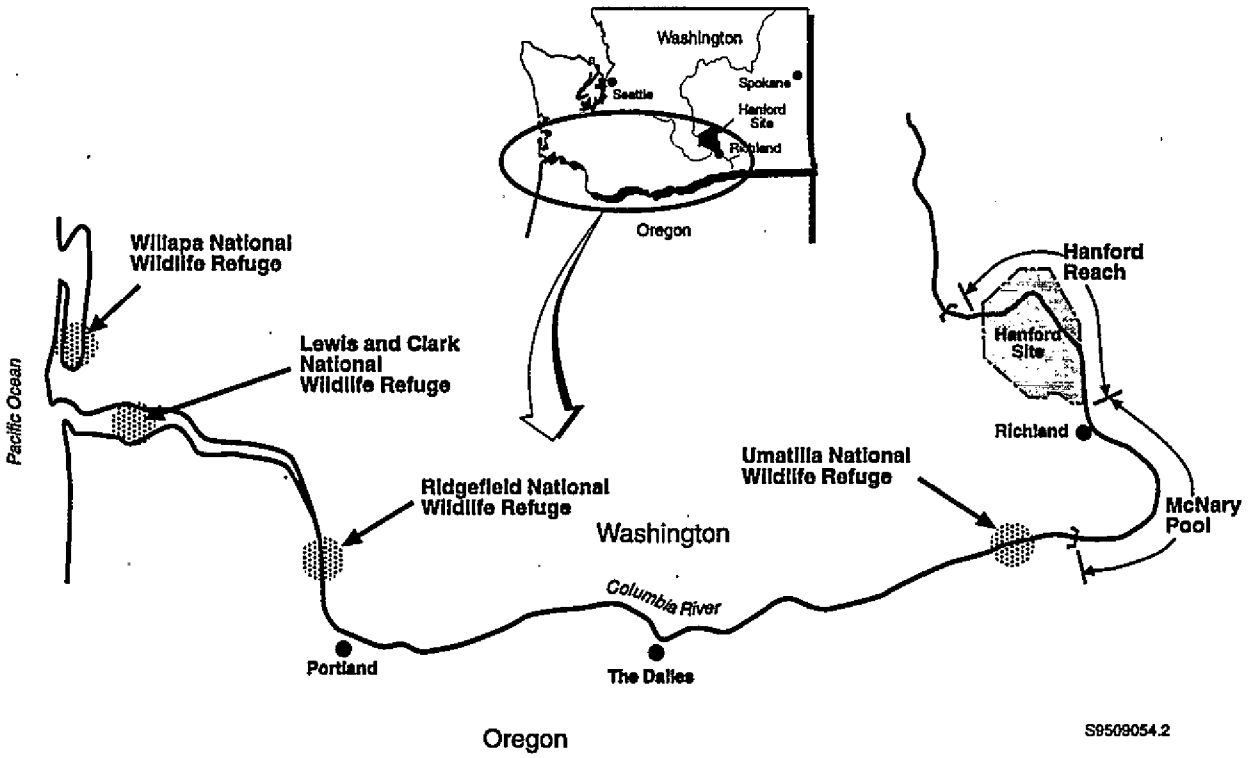

Figure 3.2. Locations of U.S. Fish and Wildlife Service National Wildlife Refuges Consulted for Preparation of the Master Species List

3.1.2 Study Area Species List

The 368 study area species were screened using a set of six criteria developed by a panel of regional biologists from federal and state resource management agencies (Table 3.1).

Table 3.1. Panel Members Who Developed the Criteria Used to Screen Study Area Species

Pacific Northwest National Laboratory	Federal and State Resource Management Agencies
D. Becker	L. Block (U.S. Fish and Wildlife Service)
C. Brandt	P. Camp (Bureau of Land Management)
C. Cushing	C. Christiansen (U.S. Army Corps of Engineers)
D. Dabble	G. Dorsey (U.S. Army Corps of Engineers)
S. Friant	L. Fitzner (Washington Department of Wildlife)
D. Geist	D. Linehan (U.S. Fish and Wildlife Service)
J. Hall	G. McCabe (National Marine Fisheries Service)
D. Maughan	L. Mettler (U.S. Army Corps of Engineers)
R. Mazaika	S. Norwood (Washington Department of Natural Resources)
D. Neitzel	T. Panskey (Bonneville Power Administration)
W. Rickard	D. Pock (Grant County Public Utility District)
M. Sackschewsky	D. Rondorf (National Biological Survey)
D. Schreffler	B. Shank (Bonneville Power Administration)
	D. Yon (Oregon Department of Environmental Quality)

The six criteria developed by the panel were:

- commercial or recreational significance
- protection status under the Endangered Species Act or similar state legislation
- critical component of either the riparian or aquatic ecosystem, in other words, key predator or prey
- high potential exposure to contaminants
- availability of toxicological benchmarks for the species
- suitably representative of a foraging guild

Each species received a "yes" or "no" response to each of the criteria. The number of "yes" responses for each criterion was arranged in a cumulative frequency distribution. Ninety-three species were above the 88th percentile of the distribution. The 88th percentile is the value that indicates the percent of a distribution that is equal to or below the distribution. Each of these had a "yes" response to three or more of the six criteria. This partial list of Tier I species was submitted to the CRCIA Team for review and input. Based on their recommendations, 88 species were added to provide a final list of 181 Tier I receptor species (Table 3.2 and Appendix B). These species provided a balanced representation of the taxa in the study area species list and were thus identified for further evaluation in the screening assessment of ecological risk.

3.2 Tier II Receptor Species Screen

A list of Tier II receptor species was identified using the following protocol. The 181 Tier I receptor species were qualitatively ranked based on a scoring of their exposure and sensitivity to contaminants using a conceptual exposure model for the study area. In the model, species were scored based on 1) potential dietary exposure to biomagnifying and non-biomagnifying contaminants, 2) potential dermal and inhalation exposure to contaminants, 3) potential exposure to contaminated media weighted to reflect their relative importance at the two types of source areas (outfall and in-river), 4) exposure duration, and 5) sensitivity to contaminants.

The resulting scores were presented to the CRCIA Team. The CRCIA Team then identified 65 of these as tentative Tier II receptor species based on their rank and ecological importance. These 65 were further reduced to 43 final Tier II receptor species by excluding 1) those with the lowest rank, 2) those that virtually never use the river and riparian areas, and 3) those within the same foraging guild that have the largest body weight. These 43 Tier II receptor species are those for which contaminant exposures and effects will be analyzed in the screening assessment of ecological risk.

3.2.1 Methods

In general, the magnitude of an individual's exposure to a contaminant is a function of 1) the concentration of the contaminant in the media (in other words, air, groundwater, prey, sediment, soil, and surface water), 2) the number of media contacted by the individual, 3) the number of pathways (in other words, dermal, ingestion, inhalation) by which contaminated media may enter the organism, and 4) the duration of an individual's contact with the contaminated media.

Table 3.2. Number of Species by Taxonomic Group at Various Stages of the Tier I Screening Process

Stages	Algae	Amphibians	Aquatic Invertebrates	Birds	Emergent Vegetation	Fish	Fungi	Macrophytes	Mammals	Reptiles	Terrestrial Invertebrates	Terrestrial Vegetation	Total
No. of Study Area Species	17	6	12	112	22	51	0	4	30	1	1	112	368
No. of Study Area Species Selected by Panel Screening	12	2	9	29	8	17	0	4	9	0	0	3	93
Percent of Study Area Species Selected by Panel Screening	71%	33%	75%	26%	36%	33%	0%	100%	31%	0%	0%	3%	25%
No. of Species Added by the CRCIA Team	0	2	6	19	1	7	1 [a]	0	12	7	7	26	88
Total No. of Tier I Species [b]	12	4	15	48	9	24	1	4	21	7	7	29	181
Percent of Total Number of Tier I Species	7%	2%	8%	26%	5%	13%	1%	2%	12%	4%	4%	16%	100%

a. Fungi were added by the CRCIA Team as a broad taxonomic group and were evaluated as such in the Tier II receptor species screen.
b. The number of Tier I species was derived by summing the number of study area species identified by the panel screening with the number of species added by the CRCIA Team.

To arrive at a simplified conceptual exposure model, species were first grouped by life style, in other words, as either fully aquatic, semi-aquatic, or primarily riparian. Within life styles, species were grouped primarily by major taxa, for example, amphibian, bird, fish, insect, mammal, plant, reptile. Within taxonomic groups, species were grouped largely by foraging strategy, for example, carnivore, herbivore, omnivore. These groups were qualitatively screened for potential exposure to contaminants in abiotic media using a general conceptual exposure model for contaminant source areas in the study area (Table 3.3). Each taxonomic group and foraging guild was evaluated to determine its potential exposure to these media at one or more critical life stages. Results are shown in Tables 3.4, 3.5, and 3.6 for aquatic, semi-aquatic, and terrestrial species, respectively.

Table 3.3. Contaminant Source Areas and Their Potentially Contaminated Media within the Study Area

(Filled cells indicate contaminated media at the source areas. Blank cells indicate media at the source areas that are not contaminated or have very low contamination levels relative to the other media.)

Contaminant Source Areas	Media					
	Sediment	Surface Water	Pore Water	Groundwater	Soil	Air
Outfalls	•	•	•	•	•	•
McNary Pool	•	•	•			
Sloughs	•	•	•			
Deep Holes	•	•	•			
Near-Shore Areas	•	•	•			

Of the 181 Tier I receptor species, some were grouped based on similar life styles and foraging strategies resulting in 120 species. The CRCIA Team added 5 species to the 120 for a total of 125 species to be scored for their potential exposure to contaminants using the conceptual exposure model described above. Scores were scaled to reflect the magnitude of a species' potential exposure to contaminants in each medium, the duration of exposure, and the sensitivity to contaminants. Species were scored specifically on:

- exposure to media, in other words, ingestion of prey with separate scores assigned for biomagnifying and non-biomagnifying contaminants, sediments/soils, pore water/groundwater, and surface water; dermal contact with sediments/soils, pore water/groundwater, and surface water; and inhalation of airborne contaminants. All media scores were scaled from 1 to 4 to ensure that all pathways/media were considered of equal importance in their contribution to an individual's overall exposure. Sections 3.2.2-3.2.8 describe the basis of score assignments.

- exposure duration, in other words, residence time in the study area. Exposure duration scores were scaled from 1 to 4. Section 3.2.9 describes the basis of score assignments.

- sensitivity to contaminants, which was estimated using the LD_{50} (median lethal dose - the dose that is lethal to 50 percent of test organisms) for radiation exposure (Whicker and Schultz 1982). Sensitivity scores were also scaled from 1 to 4. Section 3.2.10 describes the basis of score assignments.

Table 3.4. General Conceptual Exposure Model Depicting Exposure Pathways/Media for Potential Aquatic Species

(Filled cells indicate scenarios where exposure pathways are complete at one or more life stages. Blank cells indicate scenarios where exposure pathways are incomplete.)

Primary Group	Secondary Group/Species	Exposure Pathways/Media[a]					
		Dermal Exposure			Ingestion Exposure		
		Sediment	Pore Water/ Groundwater	Surface Water	Sediment	Pore Water/ Groundwater	Surface Water
Primary producers	Algae	•[b]	•	•	NA[c]	NA	NA
	Macrophytes	•	•	•	•	•	NA
Invertebrates	Benthos	•	•		•	•	
	Zooplankton			•			•
	Macroscopic Arthropods	•	•	•	•	•	•
	Mollusks	•	•	•	•	•	•
Resident fish	Herbivores, e.g. • sucker	•[d]	•[d]	•	•	•	•
	Carnivores,[e] e.g., • rainbow trout • squawfish • sturgeon • bass	•[d]	•[d]	•	•[f]	•[f]	•
Non-resident fish; i.e. anadromous species	Carnivores, e.g. • lamprey • shad • chinook salmon	•[d]	•[d]	•	Anadromous species do not feed in the river		
Amphibians	Bullfrog	•	•	•	•[g]	•[g]	•[g]

a. The inhalation pathway is not applicable for species which respirate water; i.e., all of these aquatic species except the bullfrog. For the bullfrog the inhalation pathway is assumed to be complete.
b. All • = exposure at all life stages unless otherwise indicated.
c. NA = Not Applicable.
d. Exposure of eggs only.
e. Carnivorous fish include those which ingest invertebrates and/or other fish.
f. None for piscivores.
g. Exposure of larvae only.

Table 3.5. General Conceptual Exposure Model Depicting Exposure Pathways/Media for Potential Semi-Aquatic Species

(Filled cells indicate scenarios where exposure pathways are complete at one or more life stages. Blank cells indicate scenarios where exposure pathways are incomplete.)

Primary Group	Secondary Group/Species	Exposure Pathways/Media[a]					
		Dermal Exposure			Ingestion Exposure		
		Sediment/ Soil	Pore Water/ Groundwater	Surface Water	Sediment/ Soil	Pore Water/ Groundwater	Surface Water
Plants	Emergent Vegetation	•[b]	•	•	•	•	NA[c]
Birds	Wading Birds and Aquatic Insectivores	•		•	•	•	•
	Piscivores, e.g. • merganser • loon • pelican • cormorant	•[d]		•	•		•
	Herbivores, e.g. • redhead duck • goose/mallard	•[d]		•	•		•
Mammals	Carnivores, e.g. • river otter	•		•			•
	Herbivores, e.g. • beaver	•		•	•		•
	Omnivores, e.g. • muskrat	•		•	•	•	•
Amphibians	Woodhouse's toad	•	•[e]	•	•[e]	•[e]	•[e]

a. The inhalation pathway is assumed to be complete for these semi-aquatic species.
b. All • = exposure at all life stages unless otherwise indicated.
c. NA = Not Applicable.
d. Includes preening exposure.
e. Exposure of larvae only.

Table 3.6. General Conceptual Exposure Model Depicting Exposure Pathways/Media for Potential Terrestrial Species

(Filled cells indicate scenarios where exposure pathways are complete at one or more life stages. Blank cells indicate scenarios where exposure pathways are incomplete.)

		Exposure Pathways/Media[a]					
		Dermal Exposure			Ingestion Exposure		
Primary Group	Secondary Group/Species	Soil	Groundwater	Surface water	Soil	Groundwater	Surface Water
Plants	Deep-Rooted	•[b]	•	•	•	•	NA[c]
	Shallow-Rooted	•		•	•		NA
Insects	Insects	•		•	•		•
Birds	Insectivores, e.g. • swallow • kingbird	•[d]		•	•		•
	Carnivores, e.g. • kingfisher • Bald eagle • osprey	•[d]		•			•
Mammals	Bats						•
	Insectivores, e.g. • shrew • grasshopper mouse	•		•	•		•
	Herbivores, e.g. • mice • porcupine • deer	•		•	•		•
	Carnivores/Omnivores, e.g. • coyote • skunk	•		•			•
Reptiles	Lizards	•			•		
	Snakes	•		•	•		

a. The inhalation pathway is assumed to be complete for these terrestrial species.
b. All • = exposure at all life stages.
c. NA = Not Applicable.
d. Includes preening exposure.

Three types of score summaries were performed:

First, scores of exposure to media were summed separately for biomagnifying and non-biomagnifying contaminants with all media assumed to contribute equally to exposure.

Second, media scores were weighted to reflect the degree of exposure to contaminants at the two types of source areas (in-river and outfall). Weighted scores were summed for biomagnifying and non-biomagnifying contaminants at the two types of source areas. Weighted scores were averaged across source areas and across biomagnifying/non-biomagnifying contaminants to obtain a grand average exposure score. Species were ranked based on these grand average exposure scores.

Third, grand average exposure scores (divided by 10 to retain the same scale as exposure duration and sensitivity) were added to exposure duration and sensitivity scores to obtain a single composite effect score. Species were also ranked based on these composite effect scores.

All rankings were assigned within taxonomic groups (in other words, algae, amphibians, aquatic invertebrates, birds, emergent vegetation, fish, fungi, macrophytes, mammals, reptiles, terrestrial invertebrates, and terrestrial vegetation). The results of the scoring are shown in Appendix C. The following sections explain the basis of the score assignments and thus the ultimate rankings.

3.2.2 Biotic Ingestion Pathway: Exposure to Contaminants in Prey

The magnitude of an individual's biotic ingestion exposure depends on the composition of the individual's prey and the contaminant body burdens of the various prey. The latter is related to the species' position in the food chain (Figures 1.1 and 1.2) and whether biomagnifying or non-biomagnifying contaminants are present. Biomagnifying contaminants are those that tend to occur in higher concentrations at higher food chain levels through dietary accumulation. Non-biomagnifying contaminants are those that tend to decrease in concentration at higher levels in the food web. Consequently, species at the top of the food chain received a higher score for biomagnifying contaminants and a lower score for non-biomagnifying contaminants. Conversely, species at the base of the food chain received a lower score for biomagnifying contaminants and a higher score for non-biomagnifying contaminants (Table 3.7). For example, the bald eagle is a top level carnivore. It received a biomagnifier score of 4 and a non-biomagnifier score of 1. In contrast, the largescale sucker is a herbivore. It received a biomagnifier score of 2 and a non-biomagnifier score of 3. Emergent vegetation is classified as a producer. It received a biomagnifier score of 1 and a non-biomagnifier score of 4.

Table 3.7. Scoring Scheme for Tier I Species' Ingestion Exposure to Contaminants in Prey

Predator Food Chain Level	Type of Contaminant in Prey	
	Biomagnifying	Non-Biomagnifying
Producer	1	4
Herbivore	2	3
Omnivore	3	2
Carnivore	4	1

3.2.3 Abiotic Ingestion Pathway: Exposure to Contaminants in Sediments/Soils and Pore Water/Groundwater

The magnitude of an individual's ingestion exposure to contaminants in sediments/soils and pore water/groundwater depends on the frequency and intimacy of an individual's contact with these media. Species whose foraging strategy and life style allow frequent ingestion of sediments/soils and pore water/ groundwater throughout their entire lives received a higher score. Species whose foraging strategy and life style allow only occasional ingestion of these media throughout only a portion of their lives received a lower score (Table 3.8). For example, channel catfish forage on the river bottom throughout most of their lives where they ingest sediments and pore water incidental to consumption of benthic invertebrates. Thus, catfish received a score of 4 for ingestion of these media. Chinook salmon feed in the river only as juveniles when they feed both in the water column and on the river bottom. Thus, they occasionally ingest sediments and pore water during consumption of aquatic insect larvae. Although adult chinook return to the study area to spawn, they do not feed during their up-river migration or spawning. Thus, chinook received a score of 1 for ingestion of sediments and a score of 1 for ingestion of pore water. The western harvest mouse occasionally ingests soils throughout its entire life incidental to consumption of vegetation and invertebrates. The harvest mouse does not consume prey from the river. Thus, the harvest mouse received a score of 2 for ingestion of soils and a score of 0 for ingestion of pore water/groundwater.

Table 3.8. Scoring Scheme for Tier I Species' Ingestion Exposure to Contaminants in Sediments/Soils and Pore Water/Groundwater

	Life Stage		
Frequency of Exposure	Juvenile	Adult	Whole Life
None	0	0	0
Occasional	1	1	2
Often	2	2	4

3.2.4 Abiotic Ingestion Pathway: Exposure to Contaminants in Surface Water

The magnitude of an individual's ingestion exposure to contaminants in surface water depends primarily on whether it drinks from the river or consumes prey from the river. Species that drink and consume food from the river, such as fish, benthic invertebrates, piscivorous birds, and muskrat, received a score of 4 for ingestion of surface water (Table 3.9). Species that drink from, but do not feed in the river, such as beaver, California quail, and owls, received a score of 2 for ingestion of surface water.

Table 3.9. Scoring Scheme for Tier I Species' Ingestion Exposure to Contaminants in Surface Water

Degree of Exposure			
Neither Drinks nor Consumes Prey from the River	Drinks from the River	Consumes Prey from the River	Drinks and Consumes Prey from the River
0	2	2	4

3.2.5 Dermal Pathway: Exposure to Contaminants in Sediments/Soils and Pore Water/Groundwater

Those species whose life styles allow frequent dermal contact with sediments/soils and pore water/ groundwater throughout their entire lives were scored higher. Species whose life style allows only occasional dermal contact with these media throughout only a portion of their lives received a lower score (Table 3.10). For example, all of the avian species occasionally bathe in dust after fledging and thus received a score of 2 for dermal exposure to soils. However, avian species virtually never make dermal contact with pore water in the river and thus received a score of 0 for this medium. All of the mammals, except bats, make occasional extensive dermal contact with soils via burrowing, resting, etc. throughout their entire lives and thus received a score of 2 for dermal exposure to soils. Like birds, however, mammal species virtually never make dermal contact with pore water and thus received a score of 0 for this medium. In contrast, benthic species, such as catfish and aquatic invertebrates, spend most of their lives in contact with sediments and pore water and thus received a score of 4 for dermal exposure to both these media.

Table 3.10. Scoring Scheme for Tier I Species' Dermal Exposure to Contaminants in Sediments/Soils and Pore Water/Groundwater

	Life Stage		
Frequency of Exposure	Juvenile	Adult	Whole Life
None	0	0	0
Occasional	1	1	2
Often	2	2	4

3.2.6 Dermal Pathway: Exposure to Contaminants in Surface Water

The magnitude of an individual's dermal exposure to contaminants in surface water depends on whether it is never immersed, seldom immersed, frequently immersed, or always immersed (Table 3.11). For example, species whose life style is completely aquatic, such as aquatic vegetation, benthic invertebrates, and fish, received a score of 4 for dermal exposure to surface water. Species which are semi-aquatic, such as the piscivorous birds and some of the mammals, received a score of 2. Species which are terrestrial and are seldom immersed in the river, such as the blackbird, bald eagle, and deer, received a score of 1. Terrestrial species which are virtually never in the river, such as mice, northern harrier, American kestrel, and owls, received a score of 0.

Table 3.11. Scoring Scheme for Tier I Species' Dermal Exposure to Contaminants in Surface Water

Frequency of Immersion in River Water			
Never	Seldom	Frequent	Always
0	1	2	4

3.2.7 Inhalation Pathway: Exposure to Contaminants in Air

Because the source of airborne contaminants in the study area is soil or surface water, the magnitude of an individual's inhalation exposure is a function of the amount of time the individual is close to these media. For example, species that spend most of their time within 0.5 m of the surface received a higher score than those that spend most of their time more than 1.0 m from the surface (Table 3.12). Ground-nesting birds that forage on the water or ground, such as geese and dabbling ducks, received a score of 3 for inhalation exposure. Birds that forage on the water or ground but nest in trees, such as the great blue heron and blackbird, received a score of 2. Birds that occasionally forage on the water or ground and nest in trees, such as the raptors, received a score of 1. Completely aquatic species, such as macrophytes, benthic invertebrates, and fish, respire water and thus received a score of 0 for inhalation of air-borne contaminants. Respiration of water-borne contaminants by fully aquatic species was scored under dermal exposure.

Table 3.12. Scoring Scheme for Tier I Species' Inhalation Exposure to Contaminants in Air

Distance above the Surface		
Mostly > 1.0 m	Mostly < 1.0 m	Always < 0.5 m
1	2	3

3.2.8 Media Weighting

As noted in Table 3.3, media contamination varies between source areas. A weighting scheme was devised to account for this variation by scoring media according to their level of contamination at the two types of source areas, outfall and in-river. In-river source areas include deep holes, McNary Pool, near-shore areas, seeps/springs, and sloughs. Scores consist of 0 (little or no contaminant burden), 1 (moderate contaminant burden), and 2 (high contaminant burden).

For the in-river source areas, most of the contaminant burden is associated with in-flowing contaminated groundwater, pore water, and sediments. The high volume and flow rate of the Columbia River rapidly dilutes water-borne contaminants to well below groundwater levels (Dirkes and Hanf 1995). The air contaminant burden is thus low in these areas. In contrast, surface soils, not groundwater, are the primary contaminated medium at the outfall source areas. Air, therefore, received a score of 2 at the outfall and 0 at the in-river source areas. Sediments and soils serve as a sink for contaminants at both the in-river and outfall areas, respectively, and thus received a score of 2 for both. Many aquatic and terrestrial prey species are likely to contact contaminants at the outfall and in-river areas (for example, in prey, sediment, soil, groundwater, pore water, surface water, air). Thus, prey received a score of 2 for both. Pore water/ groundwater received a score of 1 at the outfall and a score of 2 at the in-river areas. Although contaminants enter surface water directly from the outfall and in-river areas, water-borne contaminants are highly diluted by the river. Thus, surface water received a score of 1 for both these source areas (Table 3.13).

Table 3.13. Media Weighting Reflecting Relative Levels of Contamination at Outfalls and In-River Source Areas

Source Area	Media				
	Air	Prey	Sediments/Soils	Groundwater/ Pore Water	Surface Water
Outfalls	2	2	2	1	1
In-river source areas	0	2	2	2	1

3.2.9 Exposure Duration

The magnitude of an individual's exposure to contaminants also depends on exposure duration. Duration scores were scaled to cover the same range as the exposure scores (Table 3.14). Species that migrate through the study area received a score of 1. Species that migrate but remain in the area for one or two seasons received a score of 2. Species that reside in the study area year-round received a score of 4.

Table 3.14. Scoring Scheme for Exposure Duration

Residence Time in Study Area		
Only Briefly in Study Area	In Study Area 1 or 2 Seasons	Lifetime Resident of Study Area
1	2	4

3.2.10 Sensitivity to Contaminants

Sensitivity scores were scaled to cover the same range as the scores for exposure to media and exposure duration scores (in other words from 1 to 4). Because most of the contaminants are radionuclides, general sensitivity to radiation was used as the basis for scoring. Species were grouped into broad taxonomic groups and scored based on LD_{50} thresholds for radiation exposure (Whicker and Schultz 1982). For example, lower plants received the lowest score, and mammals and birds received the highest score because they are the most sensitive to radiation exposure (Table 3.15).

Table 3.15. Scoring Scheme for Sensitivity to Radiological Contaminants (Scores Based on Ld_{50} for Radiation Exposure)

Lower Plants	Higher Plants/Insects	Amphibians/ Fish/Reptiles	Birds/Mammals
1	2	3	4

3.2.11 Summary of Scores

The scores for each species' exposure to media, exposure duration, sensitivity to contaminants, and the media weightings were summarized as follows:

1. Scores of abiotic ingestion exposure to sediment/soil (Appendix C, row 6), groundwater/pore water (Appendix C, row 7), and surface water (Appendix C, row 8) were summed (Appendix C, row 5) and added separately to scores of biotic ingestion exposure to biomagnifying contaminants in prey (Appendix C, row 3) and non-biomagnifying contaminants in prey (Appendix C, row 4). This provided summary scores indicating ingestion exposure to biomagnifying contaminants (Appendix C, row 1) and non-biomagnifying contaminants (Appendix C, row 2) in all media with all media treated equally.

2. Scores of dermal exposure to sediment/soil (Appendix C, row 10), groundwater/pore water (Appendix C, row 11), and surface water (Appendix C, row 12) were summed. This provided summary scores (Appendix C, row 9) indicating dermal exposure to contaminants in all media with all media treated equally.

3. Inhalation scores (Appendix C, row 13) and dermal summary scores (Appendix C, row 9) were summed and added separately to ingestion summary scores for biomagnifying contaminants (Appendix C, row 1) and non-biomagnifying contaminants (Appendix C, row 2). This provided summary scores indicating overall exposure to biomagnifying contaminants (Appendix C, row 14) and non-biomagnifying contaminants (Appendix C, row 15) in all media with all media treated equally.

4. Media weightings for the outfall and in-river source areas (see Table 3.13) were multiplied with scores of abiotic ingestion exposure to sediment/soil (Appendix C, row 6), groundwater/pore water (Appendix C, row 7), and surface water (Appendix C, row 8), with scores of dermal exposure to sediment/soil (Appendix C, row 10), groundwater/pore water (Appendix C, row 11), and surface water (Appendix C, row 12), with scores of inhalation exposure (Appendix C, row 13), and with scores of biotic ingestion exposure to biomagnifying contaminants in prey (Appendix C, row 3) and non-biomagnifying contaminants in prey (Appendix C, row 4). These products were summed separately for biomagnifying contaminants and non-biomagnifying contaminants. This provided summary scores indicating overall exposure to biomagnifying contaminants and non-biomagnifying contaminants at the in-river (Appendix C, rows 17 and 18) and outfall (Appendix C, rows 20 and 21) source areas.

5. Summary scores of overall exposure to biomagnifying contaminants and non-biomagnifying contaminants at the outfall (Appendix C, rows 20 and 21) and in-river (Appendix C, rows 17 and 18) source areas were averaged to produce an in-river average and an outfall average (Appendix C, rows 23 and 24). This provided summary scores indicating overall exposure at the outfall and in-river source areas.

6. Species were ranked based on their average exposure scores from the in-river and outfall source areas. These rankings are not shown in Appendix C. Species' rank order differed only slightly between in-river and outfall source areas. Consequently, average exposure scores from the in-river and outfall source areas were averaged to produce a grand average exposure score (Appendix C, row 25). Species were rank-ordered within major taxonomic groups based on this grand average to provide an indication of relative exposure among species (Appendix C, row 26).

7. Because grand average exposure scores ranged up to 41, it was necessary to divide these by 10 so that they could be added to the exposure duration and sensitivity scores and keep the same scale. These quotients were added to exposure duration (Appendix C, row 28) and sensitivity scores (Appendix C,

row 29) to produce composite effect scores (Appendix C, row 31). Species were also rank-ordered within major taxonomic groups based on these composite effect scores (Appendix C, row 32).

8. The sensitivity scoring did not differentiate within taxonomic groups (in other words, determining sensitivity differences at the species level will require data that have not yet been assembled, but will be available for the ecological risk assessment. Thus, the sensitivity scoring provided no additional information to differentiate species within major taxonomic groups, although it did emphasize that representatives of major taxonomic group should be included in the ecological risk assessment. Also, exposure duration scoring is less meaningful because toxicity data are often based on 48-hour to 96-hour exposures. Even the lowest exposure duration for species given a score of 1 exceeds 48 hours. Therefore, the grand average exposure scores (see point 6 above) were considered to be more valuable than the composite effect scores (see point 7 above) for the purposes of this receptor species screen.

3.2.12 Identification of Final Tier II Receptor Species

The CRCIA Team selected 65 of the ranked Tier I species (Appendix C, rows 26 and 32) as tentative Tier II receptor species. These were further reduced to 43 final Tier II receptor species (Table 3.16). Where two species belonged to the same foraging guild and had approximately the same grand average exposure score, the smaller species was chosen for further evaluation because of the general positive correlation between exposure and body weight (Opresko et al. 1993), in other words, the lower the body weight, the lower the toxicity threshold. Species that virtually never occur in the river or riparian zone were also eliminated. Finally, species with the lowest ranks were not included in the 43 final Tier II receptor species.

The number and percent of Tier I species retained during the Tier II receptor screening process are shown in Table 3.17.

Table 3.16. Tier II Receptor Species

Taxa/Species*	Rank Based on Grand Average Exposure Scores	Rank Based on Composite Effect Scores	Selected by CRCIA Team as Tentative Tier II Receptor Species	Final Tier II Receptor Species
Algae				
Periphyton	1	1	*	+
Amphibians				
Bullfrog	1	1	*	+
Spadefoot toad	2	1	*	(b)
Woodhouse's toad	2	1	*	(b)
Aquatic Invertebrates				
Caddisfly	1	1	*	(b)
Crayfish	1	1	*	+
Fresh water shrimp	1	1	*	+
Mayfly	1	1	*	+
Midge	1	1	*	(b)
Clams/mussels/Snails	1	1	*	+
Water flea	10	10	*	+
Birds				
American coot	1	1	*	+
Common snipe	3	2	*	+
Diving ducks (e.g., bufflehead)	7	20	*	+
Goose/Mallard	8	5	*	+
Great blue heron	8	5	*	+
American white pelican	11	7	*	+
Common merganser	11	21	*	(b)
Forster's tern	11	21	*	+
Pied-billed grebe	11	7	*	(b)
California quail	17	11	*	+
Red-winged blackbird	17	23	*	(b)
Cliff swallow	21	25	*	+
Belted kingfisher	22	26	*	(b)
Osprey	22	26	*	(b)
Bald eagle	24	28	*	+
Northern harrier	26	13	*	+
American kestrel	29	16	*	+
Barn owl	29	16	*	(c)
Emergent Vegetation				
Columbia yellowcress	1	1	*	+
Common cattail	1	1	*	(b)
Rush (all)	1	1	*	+
Fish				
Channel catfish	1	1	*	+
Largescale sucker	2	2	*	+
Mountain sucker	2	2	*	+
Paiute sculpin	4	4	*	(b)
Carp	6	6	*	+
Mountain whitefish	6	6	*	+

Table 3.16. (contd)

Taxa/Species*	Rank Based on Grand Average Exposure Scores	Rank Based on Composite Effect Scores	Selected by CRCIA Team as Tentative Tier II Receptor Species	Final Tier II Receptor Species
White sturgeon	6	6	*	+
Pacific lamprey	9	16	*	+
Shiner	9	9	*	(b)
Salmon (all)	12	17	*	+
Squawfish	12	11	*	(c)
Trout (bull and rainbow)	12	11	*	(b)
Steelhead	18	18	*	+
Fungi	1	1	*	+
Macrophytes				
Water milfoil	1	1	*	(b)
Duckweed	3	3	*	(b)
Mammals				
Muskrat	1	1	*	+
Beaver	3	3	*	+
Coyote	3	3	*	(b)
Raccoon	3	3	*	+
Mule deer	7	7	*	(b)
Great Basin pocket mouse	8	8	*	(a)
Weasel	8	8	*	+
Western harvest mouse	8	8	*	+
Reptiles				
Western garter snake	1	1	*	+
Terrestrial Vegetation				
Black cottonwood	1	1	*	+
Columbia milk vetch	1	1	*	(a)
Dense sedge	1	1	*	+
Fern	1	1	*	+
Mulberry	1	1	*	+
Reed canarygrass	1	1	*	+
Rushes	1	1	*	+
Willow (all)	1	1	*	(b)

* Terrestrial invertebrates are not included in this table because no species in this taxon were selected by the CRCIA Team as tentative Tier II receptor species.

\+ One of the 43 Tier II receptor species

a. Species that virtually never occur in the river or riparian zone

b. Species with a life style similar to that of another Tier II receptor species

c. Species with low grand average exposure scores

Table 3.17. Number of Tier I Species by Taxon that Were Retained in the Tier II Receptor Species Screen

	Algae	Amphibians	Aquatic Invertebrates	Birds	Emergent Vegetation	Fish	Fungi	Macrophytes	Mammals	Reptiles	Terrestrial Invertebrates	Terrestrial Vegetation	Total
No. of Tier I Species	12	4	15	48	9	24	1	4	21	7	7	29	181
No. of Tier I Species Selected by the CRCIA Team as Tentative Tier II Receptor Species	1[a]	3	7	18	3	13	1	2	8	1	0	8	65
Percent of Tier I Species Selected by the CRCIA Team as Tentative Tier II Receptor Species	8%	75%	47%	38%	33%	54%	100%	50%	38%	14%	0%	27%	35%
No. of Tier I Species Selected as Final Tier II Receptor Species	1[a]	1	5	12	2	9	1	0	5	1	0	6	43
Percent of Tier I Species Selected as Final Tier II Receptor Species	8%	25%	33%	25%	22%	38%	100%	0%	24%	14%	0%	20%	23%

a. Periphyton, a broad taxon that includes many algae species, was selected as a tentative and a final Tier II receptor species (see Table 3.16).

4.0 Use of Tier II Receptor Species

The 43 final Tier II receptor species will be evaluated as follows in the screening assessment of ecological risk. Exposures to contaminants will be estimated for these species within the study area using exposure models that integrate exposure over all pathways and media. Species that have different exposure regimes at different life stages (see Tables 3.4-3.6) present a special problem that will be addressed by estimating exposures for each life stage separately. Exposure estimates will be compared to toxicological benchmarks (equivalent to measurement endpoints in the U.S. Environmental Protection Agency methodology) (EPA 1992) that reflect mortality (for example, LC_{50} - concentration producing mortality in 50 percent of the test organisms) or the lowest observed adverse effect level. Where exposures are estimated separately for two life stages, they will be compared to toxicological benchmarks specific for each life stage.

Toxicological benchmarks are being consolidated from EPA toxicological databases and other references (for example, Opresko, et al. 1993, Suter and Mabry 1994, Ramamoorthy and Baddaloo 1995). Benchmarks will be obtained or derived for each species and life stage addressed in this risk assessment.

Exposures and effects will be evaluated using deterministic and stochastic models. Deterministic models will utilize maximum source term data in a single run of the exposure model. Stochastic models will utilize the same exposure model in a Monte Carlo regime that will have the probability density functions for both the input parameters to the exposure model and the toxicological benchmarks. The deterministic models will be run for all portions of the study area. The stochastic models will be run for those portions of the study area and those receptors that show a relatively high ratio of exposure to benchmark.

Model composition, toxicological benchmarks, and model results will be presented in the screening assessment and requirements for a comprehensive assessment report.

5.0 References

50 CFR 58982. November 15, 1994. "Endangered and Threatened Wildlife and Plants; Animal Candidate Review for Listing as Endangered or Threatened Species." *Federal Register.*

42 USC 6901 et seq. October 21, 1976. *Resource Conservation and Recovery Act of 1976.* Public Law 94-580.

42 USC 9601 et seq (as amended). December 11, 1980. *Comprehensive Environmental Response, Compensation, and Liability Act of 1980.* Public Law 96-510.

Becker, C. D. 1990. *Aquatic Bioenvironmental Studies: The Hanford Experience 1944-84.* Elsevier Publishers, New York.

Brandt, C. A., C. E. Cushing, W. H. Rickard, N. A. Cadoret, and R. Mazaika. 1993. Biological Resources of the 300-FF-5 Operable Unit. WHC-SD-EN-TI-121, Westinghouse Hanford Company, Richland, Washington.

Cushing, C. E. 1994. *Hanford Site National Environmental Policy Act (NEPA) Characterization.* PNL-6415 Rev. 6, Pacific Northwest Laboratory, Richland, Washington.

Dauble, D. D., and D. G. Watson. 1990. *Spawning and Abundance of Fall Chinook Salmon (Oncorhynchus tshawytscha) in the Hanford Reach of the Columbia River, 1948-1988.* PNL-7289, Pacific Northwest Laboratory, Richland, Washington.

Dirkes, R. L., and R. W. Hanf. 1995. *Hanford Site Environmental Report for Calendar Year 1994.* PNL-10574. Pacific Northwest Laboratory, Richland, Washington.

DOE - U.S. Department of Energy. 1994. *Columbia River Impact Evaluation Plan.* DOE/RL-92-28, Rev. 1, Richland, Washington.

DOE - U.S. Department of Energy. 1995. *Hanford Site Risk Assessment Methodology.* DOE/RL-91-45, Rev. 3, Richland, Washington.

Ecology - Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy. 1994. *Hanford Federal Facility Agreement and Consent Order.* Document No. 89-10, Rev. 3 (The Tri-Party Agreement), Ecology, Olympia, Washington.

EPA - Environmental Protection Agency. 1992. *Framework for Ecological Risk Assessment.* EPA/630/R-92/001, Washington, D.C.

Eslinger, P. W., L. R. Huesties, A. D. Maughan, T. B. Miley, and W. H. Walters. 1994. *Data Compendium for the Columbia River Comprehensive Impact Assessment.* PNL-9785, Pacific Northwest Laboratory, Richland, Washington.

Fickeisen, D. H., R. E. Fitzner, R. H Sauer, and J .L. Warren. 1980. *Wildlife Usage, Threatened and Endangered Species and Habitat Studies of the Hanford Reach, Columbia River, Washington.* Pacific Northwest Laboratories, Richland, Washington.

Fitzner, R. E., and R. H. Gray. 1991. "The Status, Distribution and Ecology of Wildlife on the U.S. DOE Hanford Site: A Historical Overview of Research Activities." *Environmental Monitoring and Assessment,* 18:173-202.

Gray, R. H., and D. D. Dauble. 1977. "Checklist and Relative Abundance of Fish Species from the Hanford Reach of the Columbia River." *Northwest Science,* 51:208-215.

Landeen, D. S., M. R. Sackschewsky, and S. Weiss. 1993. *100 Areas CERCLA Ecological Investigations.* WHC-EP-0620, Westinghouse Hanford Company, Richland, Washington.

Miley, T. B., and L. R. Huesties. 1995. *List of Currently Classified Documents Relative to Hanford Operations and of Potential Use in the Columbia River Comprehensive Impact Assessment, January 1, 1973-June 20, 1994.* PNL-10459, Pacific Northwest Laboratory, Richland, Washington.

Napier, B. A., N. C. Batishko, D. A. Heise-Craff, M. F. Jarvis, and S. F. Synder. 1995. *Identification of Contaminants of Concern.* PNL-10400, Pacific Northwest Laboratory, Richland, Washington.

Napier, B. A., B. L. Harper, N. K. Lane, D. L. Strenge, and R. B. Spivey. 1996. *Columbia River Comprehensive Impact Assessment: Human Scenarios for the Screening Assessment.* DOE/RL-96-16-a, U.S. Department of Energy, Richland, Washington.

Neitzel, D. A., T. L. Page, and R. W. Hanf, Jr. 1982a. "Mid-Columbia River Microflora." *Journal of Freshwater Ecology* 1:495-505.

Neitzel, D. A., T. L. Page, and R. W. Hanf, Jr. 1982b. "Mid-Columbia River Zooplankton." *Northwest Science,* 57:111-118.

Opresko, D. M., B. E. Sample, and G. W. Suter. 1993. *Toxicological Benchmarks for Wildlife.* ES/ER/TM-86, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Page, T. L., D. D. Dauble, and D. A. Neitzel. 1982. *Skagit/Hanford Nuclear Project, Columbia River Aquatic Ecological Studies Near the Skagit/Hanford Nuclear Project: Final Report.* Battelle, Pacific Northwest Laboratories, Richland, Washington.

Ramamoorthy, S., and E. G. Baddaloo. 1995. *Handbook of Chemical Toxicity Profiles of Biological Species.* Lewis Publishers, Boca Raton, Florida.

RCW - Revised Code of Washington. 1985. "Hazardous Waste Management Act." RCW 70.105, Olympia, Washington.

Sackschewsky, M. R., D. S. Landeen, G. I. Baird, W. H. Rickard, and J. L. Downs. 1992. *Vascular Plants of the Hanford Site*. WHC-EP-0554, Westinghouse Hanford Company, Richland, Washington.

Suter, G. W. and J. B. Mabrey. 1994. *Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota: 1994 Revision*. ES/ER/TM-96/R1, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

WDW - Washington Department of Wildlife. 1994. *Species of Special Concern in Washington*. Olympia, Washington.

Weiss, S. G., and R. M. Mitchell. 1992. *A Synthesis of Ecological Data from the 100 Areas of the Hanford Site*. WHC-EP-0601, Westinghouse Hanford Company, Richland, Washington.

West, N. E. 1988. "Intermountain Deserts, Shrub Steppes, and Woodlands." *North American Terrestrial Vegetation*, eds. M.G. Barbour and W.D. Billings, pp. 209-230. Cambridge University Press, New York.

Whicker, F. W. and V. Schultz. 1982. *Radioecology: Nuclear Energy and the Environment, Volume II*. CRC Press, Boca Raton, Florida.

WNHP - Washington Natural Heritage Program. 1994. *Endangered, Threatened, and Sensitive Vascular Plants of Washington*. Washington Department of Natural Resources, Olympia, Washington.

Appendix A

Master Species List for the Screening Assessment of Ecological Risk from the Columbia River

Appendix A

Master Species List for the Screening Assessment of Ecological Risk from the Columbia River

Common Name	Scientific Name	General Location[a]	Habitat Type	Specific Location[b]
Algae				
	Achnanthes spp.	X	aquatic	HR
	Asterionella spp.	X	aquatic	HR
	Asterionella spp.	X	aquatic	HR
	Chlorophyta spp.	X	aquatic	HR
	Cladophora spp.	X	aquatic	HR
	Cocconeis spp.	X	aquatic	HR
	Cyclotella spp.	X	aquatic	HR
	Fragilaria spp.	X	aquatic	HR
	Fragilaria spp.	X	aquatic	HR
	Gomphonema spp.	X	aquatic	HR
	Melosira spp.	X	aquatic	HR
	Melosira spp.	X	aquatic	HR
	Nitzchia spp.	X	aquatic	HR
	Stephanodiscus spp.	X	aquatic	HR
	Stephanodiscus spp.	X	aquatic	HR
	Stigeoclonium spp.	X	aquatic	HR
	Synedra spp.	X	aquatic	HR
Amphibians				
Bullfrog	*Rana catesbeiana*	X	aquatic/riparian	HS; WNWR; LCNWR; RNWR
Dunn's salamander	*Plethodon dunni*		riparian	WNWR
Ensatina	*Ensatina eschscholtzii*		riparian	WNWR
Great Basin spadefoot toad	*Scaphiopus intermontanus*	X	riparian	HS; JDP
Larch mountain salamander	*Plethodon larselli*		aquatic	BP
Long-toed salamander	*Ambystoma macrodactylum*		riparian/wetland	RNWR
Northern leopard frog	*Rana pipiens*		aquatic/riparian	HS
Northern red-legged frog	*Rana aurora aurora*		upland/riparian/aquatic	BP
Northwestern salamander	*Ambystoma gracile*		riparian/wetland	WNWR; LCNWR
Olympic salamander	*Rhyacotriton olympicus*		riparian/wetland	WNWR; RNWR
Pacific chorus frog	*Pseudacris regilla*	X	aquatic/riparian	HS
Pacific giant salamander	*Dicamptodon tenebrosus*		riparian/wetland	WNWR
Pacific treefrog	*Hyla regilla*	X	aquatic/riparian	HS; DP; BP; WNWR; LCNWR; RNWR
Red-legged frog	*Rana aurora*		upland/riparian	WNWR; LCNWR; RNWR
Rough-skinned newt	*Taricha granulosa*		riparian/wetland	WNWR; LCNWR
Spotted frog	*Rana pretiosa*	X	aquatic/riparian	PRR; HS; MNR; JDP; DP; BP
Territorial woodhouse's toad	*Bufo woodhousei*	X	aquatic/riparian	HS
Van Dyke's salamander	*Plethodon vandykei*		riparian	WNWR

Common Name	Scientific Name	General Location[a]	Habitat Type	Specific Location[b]
Aquatic Invertebrates				
Caddisfly[c]	*Cheumatopsyche cockerelli*	X	aquatic/benthic	HR
Caddisfly[c]	*Cheumatopsyche campyla*	X	aquatic/benthic	HR
Caddisfly[c]	*Cheumatopsyche enonis*	X	aquatic/benthic	HR
California floater	*Andonta californiensis*	X	aquatic/benthic	HR; PRR; MNR; JDP; DP; BP
Columbia pebblesnail	*Fluminicola columbianus*	X	aquatic/benthic	PRR; HR; MNR; JDP; DP; BP
Crayfish	*Pacifasticus leniusculus*	X	aquatic/benthic	HR
Cryptomastix	*Cryptomastix* n. sp.	X	aquatic/benthic	HS
Cyclops	*Cyclops* spp.	X	aquatic/pelagic	HR
Dalles mountain snail	*Oreohelix variabilis*		aquatic/benthic	
Diaptomus	*Diaptomus* spp.	X	aquatic/benthic	HR
Midge	genera of the subfamily tanypodinae	X	aquatic/benthic	HR; MNR; JDP; DP; BP; BB
Oregon snail	*Monadenia fidelis minor*		aquatic/benthic	BP
Shortface lanx	*Fisherola nuttalli*	X	aquatic/benthic	HR
Water flea	*Bosmina* spp.; *Ceriodaphnia* spp.; *Daphnia magna*	X	aquatic/pelagic	HR
Birds				
Aleutian Canada goose	*Branta canadensis leucopareia*	X	shoreline	HS
American avocet	*Recurvirostera americana*	X	riparian/shoreline	CSRC; UNWR; RNWR; MNR
American bittern	*Botaurus lentiginosus*		riparian	CSRC; UNWR; RNWR; LCNWR; WNWR
American coot	*Fulica americana*	X	riparian/aquatic/wetland	PRR; HS; CSRC; MNR; UNWR; BB; RNWR; LCNWR; WNWR
American goldfinch	*Carduelis tristis*	X	riparian/upland	PRR; CSRC; UNWR; RNWR; LCNWR; WNWR
American pipit	*Anthus rubescens*	X	riparian/shoreline	PRR; CSRC; UNWR; RNWR; LCNWR; WNWR
American robin	*Turdus migratorius*	X	upland/riparian	PRR; HS; CSRC; UNWR; BB; RNWR; LCNWR; WNWR
American white pelican	*Pelecanus erythrorhynchos*	X	riparian/shoreline	HS; CSRC; MNR; UNWR; JDP; RNWR
American wigeon	*Anas americana*	X	riparian/aquatic/island	PRR; CSRC; MNR; UNWR; BB; RNWR; LCNWR; WNWR
Arctic tern	*Sterna paradisaea*	X	aquatic	HS; WNWR
Baird's sandpiper	*Calidris bairdii*	X	shoreline	CSRC; MNR; UNWR; WNWR
Bald eagle	*Haliaeetus leucocephalus*	X	riparian/shoreline	PRR; HS; CSRC; MNR; UNWR; JDP; BP; BB; RNWR; LCNWR; WNWR
Bank swallow	*Riparia riparia*	X	riparian/upland	CSRC; UNWR; JDP
Bar-tailed godwit	*Limosa lapponica*		coastal shoreline	WNWR
Barrow's goldeneye	*Bucephala islandica*	X	riparian/aquatic/island	CSRC; MNR; UNWR; JDP; RNWR; LCNWR; WNWR
Belted kingfisher	*Ceryle alcyon*	X	riparian/aquatic	HS; CSRC; RNWR; LCNWR; WNWR; UNWR
Black turnstone	*Arenaria melanocephala*		shoreline	WNWR

Common Name	Scientific Name	General Location[a]	Habitat Type	Specific Location[b]
Black-bellied plover	*Pluvialis squatarola*	X	shoreline	CSRC; MNR; UNWR; BB; RNWR; LCNWR; WNWR
Black-crowned night heron	*Nycticorax nycticorax*	X	aquatic/riparian	HS; CSRC-I; MNR; UNWR; JDP; RNWR
Black-necked stilt	*Himantopus mexicanus*	X	riparian/shoreline	HS; CSRC; MNR; UNWR; JDP; RNWR
Black-throated gray warbler	*Dendroica nigrescens*		riparian	RNWR; LCNWR; WNWR
Blue-winged teal	*Anas discors*	X	riparian/aquatic	CSRC; UNWR; RNWR; LCNWR; WNWR
Brandt's cormorant	*Phalacrocorax penicillatus*		semi-pelagic/aquatic	WNWR
Brown pelican	*Pelecanus occidentalis*		semi-pelagic/aquatic	WNWR
Brown-headed cowbird	*Molothrus ater*	X	upland/riparian	PRR; HS; CSRC; UNWR; RNWR; LCNWR; WNWR
Bufflehead	*Bucephala albeola*	X	riparian/aquatic/island	PRR; CSRC; MNR; UNWR; JDP; RNWR; LCNWR; WNWR
California gull	*Larus californicus*	X	riparian/island	HS; CSRC-I; MNR; UNWR; JDP; DP; BP; RNWR; LCNWR; WNWR
California quail	*Callipepla californica*	X	riparian/upland	HS; CSCR; UNWR; BP; RNWR; PRR
Canada goose	*Branta canadensis*	X	aquatic/island/riparian	PRR; HS; CSRC; MNR; UNWR; JDP; DP; BP; BB; RNWR; LCNWR; WNWR
Canvasback	*Aythya valisineria*	X	riparian/aquatic/island	CSRC; MNR; UNWR; RNWR; LCNWR; WNWR
Caspian tern	*Sterna caspia*	X	riparian/shoreline	HS; CSRC; MNR; UNWR; JDP; DP; BP; RNWR; LCNWR; WNWR
Cattle egret	*Bubulcus ibis*	X	riparian/shoreline	CSRC; RNWR; WNWR
Chukar	*Alectoris chukar*	X	riparian/upland	PRR; HS; UNWR; DP
Cinnamon teal	*Anas cyanoptera*	X	riparian/island/aquatic	PRR; CSRC; UNWR; RNWR; LCNWR; WNWR
Clark's grebe	*Aechmophorus clarkii*	X	riparian/aquatic	HS; CSRC; UNWR; JDP
Common goldeneye	*Bucephala clangula*	X	riparian/aquatic/island	PRR; CSRC; MNR; UNWR; JDP; RNWR; LCNWR; WNWR
Common loon	*Gavia immer*	X	riparian/aquatic	PRR; HS; CSRC; UNWR; JDP; RNWR; LCNWR; WNWR
Common merganser	*Mergus merganser*	X	aquatic/riparian	PRR; HS; CSRC-I; MNR; UNWR; RNWR; LCNWR; WNWR
Common snipe	*Gallinago gallinago*	X	riparian/shoreline	HS; CSRC; MNR; UNWR; BP; BB; RNWR; LCNWR; WNWR
Common tern	*Sterna hirundo*	X	aquatic	CSRC; LCNWR; WNWR
Common yellowthroat	*Geothlypis trichas*	X	riparian	UNWR; RNWR; LCNWR; WNWR
Double crested cormorant	*Phalacrocorax auritus*	X	riparian/aquatic/semi-pelagic	CSRC; MNR; UNWR; BP; RNWR; LCNWR; WNWR
Dunlin	*Calidris alpina*	X	shoreline	CSRC; MNR; UNWR; BB; RNWR; LCNWR; WNWR

Common Name	Scientific Name	General Location[a]	Habitat Type	Specific Location[b]
Eared grebe	*Podiceps nigricollis*	X	riparian/aquatic	PRR; CSRC; UNWR; RNWR
Emperor goose	*Chen canagica*		shoreline	RNWR; LCNWR; UNWR;WNWR
Eurasian wigeon	*Anas penelope*	X	riparian/aquatic	CSRC; UNWR; RNWR; LCNWR; WNWR
Forster's tern	*Sterna forsteri*	X	riparian/shoreline	HS; CSRC-I; MNR; WNWR; JDP; DP
Gadwall	*Anas strepera*	X	riparian/aquatic	HS; CSRC; MNR; UNWR; RNWR; LCNWR; WNWR
Glaucous-winged gull	*Larus glaucescens*	X	riparian/island	CSRC; UNWR; DP; RNWR; LCNWR; WNWR
Golden-Crowned kinglet	*Regulus satrapa*	X	riparian	PRR; HS; CSRC; UNWR; RNWR; LCNWR; WNWR
Golden-crowned sparrow	*Zonotrichia atricapilla*	X	riparian	HS; CSRC; UNWR; RNWR; LCNWR; WNWR
Great blue heron	*Ardea herodias*	X	riparian/shoreline/islands	PRR; HS; CSRC; MNR; UNWR; JDP; DP; BP; BB; RNWR; LCNWR; WNWR
Great egret	*Casmerodius albus*	X	riparian/shoreline	HS; CSRC; UNWR; JDP; RNWR; LCNWR; WNWR
Great white-fronted goose	*Anser albifrons*	X	shoreline	CSRC; UNWR; RNWR; LCNWR; WNWR
Greater scaup	*Aythya marila*	X	riparian/aquatic/island	CSRC; MNR; UNWR; DP; RNWR; LCNWR; WNWR; BP
Greater yellowlegs	*Tringa melanoleuca*	X	riparian/shoreline	CSRC; MNR; UNWR; RNWR; LCNWR; WNWR
Green-backed heron	*Butorides striatus*		riparian/shoreline	RNWR; LCNWR; WNWR
Green-winged teal	*Anas crecca*	X	island/riparian/aquatic	PRR; HS; CSRC; MNR; UNWR; JDP; BB; RNWR; LCNWR; WNWR
Harlequin duck	*Histrionicus histrionicus*	X	riparian/aquatic	PRR; UNWR; BP; RNWR; WNWR
Herring gull	*Larus argentatus*	X	riparian/island	CSRC; UNWR; RNWR; LCNWR; WNWR
Hooded merganser	*Lophodytes cucullatus*	X	riparian/aquatic	CSRC; MNR; UNWR; RNWR; LCNWR; WNWR
Horned grebe	*Podiceps auritus*	X	riparian/aquatic	PRR; HS; CSRC; UNWR; JDP; RNWR; LCNWR; WNWR
Killdeer	*Charadrius vociferus*	X	riparian/shoreline	HS; PRR; CSRC; MNR; UNWR; BP; BB; RNWR; LCNWR; WNWR
Least sandpiper	*Calidris minutilla*	X	estuarine/wetland/upland	CSRC; MNR; UNWR; BB; RNWR; LCNWR; WNWR
Lesser golden plover	*Pluvialis dominica*	X	aquatic/riparian/shoreline	LCNWR; WNWR; MNR
Lesser scaup	*Aythya affinis*	X	riparian/aquatic/island	CSRC; MNR; UNWR; DP; BP; RNWR; LCNWR; WNWR
Lesser yellowlegs	*Tringa flavipes*	X	riparian/shoreline	CSRC; MNR; UNWR; RNWR; WNWR
Long-billed dowitcher	*Limnodromus scolopaceus*	X	riparian/shoreline	CSRC; MNR; UNWR; RNWR; WNWR

Common Name	Scientific Name	General Location[a]	Habitat Type	Specific Location[b]
Mallard	*Anas platyrhynchos*	X	aquatic/island/riparian	PRR; HS; CSRC; MNR; UNWR; JDP; DP; BB; RNWR; LCNWR; WNWR
Marbled godwit	*Limosa fedoa*	X	coastal shoreline	MNR; UNWR; BB; WNWR
Marsh wren	*Cistothorus palustris*	X	riparian	HS; CSRC; UNWR; BB; RNWR; LCNWR; WNWR
Mourning dove	*Zenaida macroura*	X	upland/riparian	PRR; BP; HS; CSRC; UNWR; RNWR; LCNWR; WNWR
Northern pintail	*Anas acuta*	X	riparian/aquatic	HS; CSRC; MNR; UNWR; JDP; DP; BB; RNWR; LCNWR; WNWR
Northern shoveler	*Anas clypeata*	X	riparian/aquatic/island	PRR; CSRC; MNR; UNWR; RNWR; LCNWR; WNWR
Oldsquaw	*Clangula hyemalis*	X	riparian/aquatic	CSRC; UNWR; WNWR
Orange-crowned warbler	*Vermivora celata*	X	riparian	PRR; CSRC; UNWR; RNWR; LCNWR; WNWR
Osprey	*Pandion haliaetus*	X	aquatic/riparian	HS; CSRC; UNWR; JDP; BP; BB; RNWR; LCNWR; WNWR
Palm warbler	*Dendroica palmarum*		riparian	WNWR
Pectoral sandpiper	*Calidris melanotos*	X	estuarine/wetland/upland	CSRC; MNR; UNWR; RNWR; WNWR
Pied-billed grebe	*Podilymbus podiceps*	X	riparian/aquatic	PRR; CSRC; MNR; UNWR; BP; RNWR; LCNWR; WNWR
Red knot	*Calidris canutus*	X	estuarine/wetland/upland	UNWR; WNWR
Red-breasted merganser	*Mergus serrator*	X	riparian/aquatic	CSRC; UNWR; RNWR; LCNWR; WNWR
Red-necked grebe	*Podiceps grisegena*	X	aquatic	HS; CSRC; MNR; UNWR; JDP; LCNWR; WNWR
Red-tailed hawk	*Buteo jamaicensis*	X	riparian/upland	HS; CSRC; UNWR; JDP; DP; BP; BB; RNWR; LCNWR; WNWR
Red-throated loon	*Gavia stellata*		semi-pelagic/aquatic	RNWR; LCNWR; WNWR
Red-winged blackbird	*Agelaius phoeniceus*	X	wetland/riparian	PRR; HS; CSRC; MNR; UNWR; BB; RNWR; LCNWR; WNWR
Redhead	*Aythya americana*	X	riparian/aquatic/island	PRR; CSRC; MNR; UNWR; DP; RNWR
Ring-billed gull	*Larus delawarensis*	X	riparian/island	CSRC-I; UNWR; JDP; DP; RNWR; LCNWR; WNWR; HS
Ring-necked duck	*Aythya collaris*	X	riparian/aquatic/island	CSRC; MNR; UNWR; DP; RNWR; LCNWR; WNWR
Ross' goose	*Chen rossii*	X	shoreline	CSRC; RNWR; LCNWR; WNWR
Ruby-crowned kinglet	*Regulus calendula*	X	riparian	PRR; HS; CSRC; UNWR; RNWR; LCNWR; WNWR
Ruddy duck	*Oxyura jamaicensis*	X	riparian/aquatic	CSRC; MNR; UNWR; RNWR; LCNWR; WNWR
Ruddy turnstone	*Arenaria interpres*		shoreline	WNWR
Sanderling	*Calidris alba*	X	shoreline	CSRC; MNR; UNWR; BB; RNWR; WNWR

Common Name	Scientific Name	General Location[a]	Habitat Type	Specific Location[b]
Sandhill crane	*Grus canadensis*	X	riparian/island	HS; CSRC; UNWR; JDP; RNWR; LCNWR
Semi-palmated plover	*Charadrius semipalmatus*	X	shoreline	CSRC; MNR; UNWR; BB; RNWR; LCNWR; WNWR
Semipalmated sandpiper	*Calidris pusilla*	X	estuarine/wetland/upland	MNR; WNWR
Sharp-tailed sandpiper	*Calidris acuminata*		estuarine/wetland/upland	RNWR; WNWR
Short-billed dowitcher	*Limnodromus griseus*	X	riparian/shoreline	MNR; WNWR
Snow goose	*Chen caerulescens*	X	shoreline	CSRC; UNWR; RNWR; LCNWR; WNWR
Snowy egret	*Egretta thula*	X	riparian/shoreline	CSRC
Snowy plover	*Charadrius alexandrinus*	X	shoreline	MNR; UNWR; WNWR
Solitary sandpiper	*Tringa solitaria*	X	riparian/shoreline	CSRC; UNWR; RNWR
Sora	*Porzana carolina*	X	riparian/shoreline	CSRC; UNWR; BB; RNWR; WNWR; BP
Spotted sandpiper	*Actitis macularia*	X	shoreline/riparian	PRR; HS; CSRC-I; MNR; UNWR; BP; BB; RNWR; LCNWR; WNWR
Stilt sandpiper	*Calidris himantopus*	X	estuarine/wetland/upland	MNR; WNWR
Swamp sparrow	*Melospiza georgiana*	X	riparian/wetland	UNWR
Townsend's warbler	*Dendroica townsendi*	X	riparian	HS; CSRC; UNWR; RNWR; LCNWR; WNWR
Tricolored blackbird	*Agelaius tricolor*		riparian/shoreline	
Trumpeter swan	*Cygnus buccinator*	X	aquatic	HS; CSRC; UNWR; JDP; RNWR; LCNWR; WNWR
Tufted duck	*Aythya fuligula*		shoreline	WNWR
Tundra swan	*Cygnus columbianus*	X	aquatic	CSRC; BB; UNWR; LCNWR; RNWR; LCNWR
Virginia rail	*Rallus limicola*	X	riparian/shoreline	CSRC; UNWR; RNWR; LCNWR; WNWR
Western grebe	*Aechmophorus occidentalis*	X	riparian/aquatic	PRR; CSRC; MNR; UNWR; JDP; BP; BB; RNWR; LCNWR; WNWR; HS
Western sandpiper	*Calidris mauri*	X	estuarine/wetland/upland	CSRC; MNR; UNWR; BB; RNWR; LCNWR; WNWR
Western screech owl	*Otus kennicottii*	X	riparian	CSRC; UNWR; JDP; RNWR; LCNWR; WNWR
Western snowy plover	*Charadrius alexandrinus nivosus*		shoreline	
Western wood-peewee	*Contopus sordidulus*	X	riparian	PRR; HS; CSRC; UNWR; BB; RNWR; LCNWR; WNWR
Whistling swan	*Cygnus columbianus*	X	aquatic	PRR
Willet	*Catoptrophorus semipalmatus*	X	shoreline	UNWR; WNWR
Willow flycatcher	*Empidonax traillii*	X	riparian/upland	HS; CSRC; UNWR; RNWR; LCNWR; WNWR
Wilson's warbler	*Wilsonia pusilla*	X	riparian	HS; CSRC; UNWR; RNWR; LCNWR; WNWR
Wood duck	*Aix sponsa*	X	riarian/island	PRR; CSRC; MNR; UNWR; BB; RNWR; LCNWR; WNWR

Common Name	Scientific Name	General Location[a]	Habitat Type	Specific Location[b]
Yellow warbler	*Dendroica petechia*	X	riparian	PRR; CSRC; MNR; UNWR; BB; RNWR; LCNWR; WNWR
Yellow-breasted chat	*Icteria virens*	X	riparian	HS; CSRC; UNWR; RNWR
Yellow-headed blackbird	*Xanthocephalus xanthocephalus*	X	riparian/shoreline	HS; CSRC; UNWR; RNWR; LCNWR; WNWR
Yellow-rumped warbler	*Dendroica coronata*	X	riparian	PRR; HS; CSRC; UNWR; RNWR; LCNWR; WNWR
Emergent Vegetation				
Alkali bulrush	*Scirpus maritimus*	X	riparian	HS; MNR; JDP; RNWR/BIRA
Baltic rush	*Juncus balticus*	X	riparian/upland	PRR; HS; MNR; JDP; DP
Beaked spikerush	*Eleocharis rostellata*	X	shoreline	PRR
Blunt-leaf yellowcress	*Rorippa obtusa*	X	riparian	HS
Bulb-bearing water hemlock	*Cicuta bulbifera*	X	riparian	PRR
Bulrush	*Scirpus paludosus*	X	riparian	
Columbia River mugwort	*Artemisia lindleyana*	X	riparian	PRR; HS
Columbia yellowcress	*Rorippa columbiae*	X	riparian/cobble-gravel substrate/islands	PRR; HR; BP
Common cattail	*Typha latifolia*	X	riparian	HS; MNR; JDP; BP; BB; RNWR
Common reed	*Phragmites communis*	X	riparian	HS
Common spikerush	*Eleocharis palustris*	X	riparian	HS; MNR; JDP; BP; BB; RNWR/BIRA
Hardstem bulrush	*Scirpus acutus*	X	riparian	HS; MNR; JDP; BP; BB; RNWR
Hispid yellowcress	*Rorippa islandica*	X	riparian	HS; RNWR
Jointed rush	*Juncus articulatus*	X	riparian	HS
Lesser cattail	*Typha angustifolia*	X	riparian/marsh	MNR; BB
Needle spikerush	*Eleocharis acicularis*	X	riparian	HS; RNWR
Ovoid spike-rush	*Eleocharis ovata*		riparian	RNWR/BIRA
Pointed rush	*Juncus oxymeris*		marsh	BB
Slender rush	*Juncus tenuis*	X	riparian	HS; JDP; RNWR/BIRA
Small spike-rush	*Eleocharis parvula*		riparian	RNWR
Small-fruited bulrush	*Scirpus microcarpus*		riparian	RNWR/BIRA
Soft rush	*Juncus effusus*		riparian	RNWR
Softstem bulrush	*Scirpus validus*	X	riparian	HS; RNWR/BIRA
Spreading rush	*Juncus patens*	X	riparian	MNR; BP
Three-square bulrush	*Scirpus americanus*	X	riparian	HS; MNR; JDP
Torrey's rush	*Juncus torreyi*	X	riparian	HS; MNR; JDP
Western water-hemlock	*Cicuta douglasii*		riparian	RNWR
Western yellowcress	*Rorippa curvisiliqua*	X	riparian	HS; RNWR/BIRA
Fish				
American shad	*Alosa sapidissima*	X	aquatic	HR; LCNWR; BB
Black bullhead	*Ictalurus melas*	X	aquatic	HR
Black crappie	*Pomoxis nigromaculatus*	X	aquatic	HR; BB
Blue catfish	*Ictalurus furcatus*	X	aquatic	HR; CRB/SOR
Bluegill	*Lepomis macrochirus*	X	aquatic	HR
Bridgelip sucker	*Catostomus columbianus*	X	aquatic	HR

Common Name	Scientific Name	General Location[a]	Habitat Type	Specific Location[b]
Brown bullhead	*Ictalurus nebulosus*	X	aquatic	HR
Bull trout	*Salvelinus confluentus*	X	aquatic	HR; MRR; MNR; JDP; DP; BP
Burbot	*Lota lota*	X	aquatic	HR
Channel catfish	*Ictalurus punctatus*	X	aquatic	HR
Chiselmouth	*Acrocheilus alutaceus*	X	aquatic	HR
Chum	*Oncorhynchus keta*		aquatic	LCNWR; BB
Coho salmon	*Oncorrhynchus kisutch*	X	aquatic	PRR; HR; MNR; JDP; DP
Common carp	*Cyprinus carpio*	X	aquatic	HR; BB
Cutthroat trout	*Salmo clarki*	X	aquatic	HR; LCNWR
Dolly Varden	*Salvelinus malma*	X	aquatic	HR
Fall chinook	*Oncorhynchus tshawytscha*	X	aquatic	PRR; HR; MNR; JDP; DP; BB; RNWR
Lake whitefish	*Coregonus clupeaformis*	X	aquatic	HR
Largemouth bass	*Micropterus salmoides*	X	aquatic	HR; BB
Largescale sucker	*Catostomus macrocheilus*	X	aquatic	BB; HR
Leopard dace	*Rhinichthys falcatus*	X	aquatic	HR
Longfin smelt	*Spirinchus thaleichthys*		aquatic	BB
Longnose dace	*Rhinichthys catatactae*	X	aquatic	HR
Mosquito fish	*Gambusia affinis*	X	aquatic	HR
Mottled sculpin	*Cottus bairdi*	X	aquatic	HR
Mountain sucker	*Catostomus platyrhynchus*	X	aquatic	HR
Mountain whitefish	*Prosopium williamsoni*	X	aquatic	HR
Nine spine stickleback	*Pungitius pungitius*		aquatic	CRB/SOR
Northern squawfish	*Ptychocheilus oregonensis*	X	aquatic	HR; JDP
Pacific lamprey	*Entosphenus tridentatus*	X	aquatic	HR; LCNWR
Peamouth	*Mylocheilus caurinus*	X	aquatic	HR; BB
Piute sculpin	*Cottus beldingi*	X	aquatic	HR
Prickly sculpin	*Cottus asper*	X	aquatic	HR
Pumpkinseed	*Lepomis gibbosus*	X	aquatic	HR
Rainbow trout	*Oncorhynchus mykiss*	X	aquatic	HR
Redside shiner	*Richardsonius balteatus*	X	aquatic	HR
Reticulate sculpin	*Cottus perplexus*	X	aquatic	HR
River lamprey	*Lampetra ayresi*	X	aquatic	HR
Sand roller	*Percopis transmontana*	X	aquatic	HR
Shiner perch	*Cymotagaster aggregata*		aquatic	BB
Smallmouth bass	*Micropterus dolomieui*	X	aquatic	HR; JDP; BB
Sockeye salmon	*Oncorhynchus nerka*	X	aquatic	HR
Speckled dace	*Rhinichthys osculus*	X	aquatic	HR
Spring chinook	*Oncorhynchus tshawytscha*	X	aquatic	HR; PRR; MNR; JDP; DP; LCNWR; BB; RNWR
Starry flounder	*Platichthys stellatus*		estuarine	LCNWR
Steelhead trout	*Oncorhynchus mykiss*	X	aquatic	HR
Summer chinook	*Oncorhynchus tshawytscha*	X	aquatic	PRR; HR; MNR; JDP; DP; LCNWR; BB; RNWR
Tench	*Tinca tinca*	X	aquatic	HR

Common Name	Scientific Name	General Location[a]	Habitat Type	Specific Location[b]
Threespine stickleback	*Gasterosteus aculeatus*	X	aquatic	HR; BB
Torrent sculpin	*Cottus rhotheus*	X	aquatic	HR
Walleye	*Stizostedion vitreum*	X	aquatic	HR; BB
Western brook lamprey	*Lampetra richardsoni*	X	aquatic	CRB/SOR
White crappie	*Pomoxis annularis*	X	aquatic	HR
White sturgeon	*Acipenser transmontanus*	X	aquatic	HR; BB
Yellow bullhead	*Ictalurus natalis*	X	aquatic	HR
Yellow perch	*Perca flavescens*	X	aquatic	HR; BB
Macrophytes				
Duckweed	*Lemna spp.*	X	aquatic	HR
Frogs-bit	*Elodea spp.*	X	aquatic	HR
Pondweed	*Potamogeton spp.*	X	aquatic	HR
Water milfoil	*Myriophyllum spp.*	X	aquatic	HR
Mammals				
Beaver	*Castor canadensis*	X	riparian/aquatic	PRR; HS; MNR; JDP; DP; BP; BB; RNWR; LCNWR; WNWR
Big brown bat	*Eptesicus fuscus*	X	riparian/buildings	HS; LCNWR; WNWR
Black-tailed deer	*Odocoileus hemionus*	X	riparian/upland shrub-steppe	PRR; HS; MNR; JDP; DP; BP; BB; RNWR; LCNWR; WNWR
California myotis	*Myotis californicus*	X	riparian/buildings	HS; LCNWR; WNWR
Columbian white-tailed deer	*Odocoileus virginianus leucurus*		riparian/upland	BB; LCNWR; CWTDNWR
Coyote	*Canis latrans*	X	upland/riparian	PRR; HS; JDP; DP; BP; RNWR; LCNWR; WNWR
Deer mouse	*Peromyscus maniculatus*	X	riparian/upland	PRR; HS; BB; LCNWR; WNWR
Fringed myotis	*Myotis thysanodes*	X	riparian/buildings	HS
Hoary bat	*Lasiurus cinereus*	X	riparian/buildings	HS; LCNWR; WNWR
House mouse	*Mus musculus*	X	upland/riparian	HS
Little brown myotis	*Myotis lucifugus*	X	riparian/buildings	HS; LCNWR; WNWR
Long-eared myotis bat	*Myotis evotis*	X	riparian/buildings	HS; WNWR
Long-legged myotis	*Myotis volans*	X	riparian/buildings	HS; WNWR
Long-tailed vole	*Microtus longicaudus*		riparian	WNWR
Long-tailed weasel	*Mustela frenata*	X	riparian	HS; RNWR; LCNWR; WNWR
Mink	*Mustela vision*	X	riparian	HS; RNWR; LCNWR; WNWR; PRR; BP; BB
Mountain vole	*Microtus montanus*	X	riparian	HS
Muskrat	*Ondatra zibethica*	X	riparian/aquatic	PRR; HS; JDP; BP; BB; LCNWR; WNWR
Nutria	*Myocaster coypus*		riparian/aquatic	BB; LCNWR; WNWR; RNWR
Oregon vole	*Microtus oregoni*		riparian	LCNWR; WNWR
Pallid bat	*Antrozous pallidus*	X	riparian/buildings	HS
Porcupine	*Erethizon dorsatum*	X	upland/riparian	HS; DP; BP; WNWR
Raccoon	*Procyon lotor*	X	riparian	PRR; HS; MNR; JDP; DP; BP; RNWR; LCNWR; WNWR
River otter	*Lutra canadensis*	X	riparian/aquatic	HS; MNR; JDP; BB; RNWR; LCNWR; WNWR

Common Name	Scientific Name	General Location[a]	Habitat Type	Specific Location[b]
Roosevelt elk	*Cervus canadensis*	X	riparian/upland shrub-steppe	HS; BB; RNWR; WNWR
Short-tailed weasel	*Mustela erminea*	X	riparian	HS
Silver-haired bat	*Lasionycteris noctivagans*	X	riparian/buildings	HS; WNWR
Small-footed myotis	*Myotis subulatus*	X	riparian/buildings	HS
Striped skunk	*Mephitis mephitis*	X	riparian	HS; JDP; DP; BP; RNWR
Townsend's big-eared bat	*Plecotus townsendii*		riparian/buildings	
Townsend's vole	*Microtus townsendi*		riparian	BB; LCNWR; WNWR
Vagrant shrew	*Sorex vagrans*	X	riparian	HS; BB; LCNWR; WNWR
Western harvest mouse	*Reithrodontomys megalotis*	X	upland/riparian	PRR; HS
Western pipistrelle	*Pipistrellus hesperus*	X	riparian/buildings	HS
White-tailed deer	*Odocoileus virginianus*	X	riparian/upland	HS
Yuma myotis	*Myotis yumanensis*	X	riparian/buildings	HS; LCNWR; WNWR
Reptiles				
Northern alligator lizard	*Elgaria coerulea*		riparian	RNWR
Northwestern pond turtle	*Clemmys marmorata marmorata*		aquatic	BP
Painted turtle	*Chrysemys picta*	X	aquatic	HS; JDP; Irrigon Wildlife Area; UNWR
Western pond turtle	*Clemmys marmorata marmorata*		aquatic	BB
Western redback salamander	*Plethodon cinereus*		riparian	WNWR
Woodhouse's toad	*Bufo woodhousii woodhousii*		riparian	JDP
Terrestrial Invertebrates				
Columbia Gorge hesperian	*Vespericola columbianus*		riparian	
Short-tailed black swallowtail	*Papilio indra*	X	riparian	HS
Terrestrial Vegetation				
Alkali groundsel	*Senecio hydrophilis*	X	riparian/upland	HS
American brooklime	*Veronica americana*	X	riparian	HS; RNWR/BIRA
American hedge-hyssop	*Gratiola neglecta*		riparian	RNWR/BIRA
American water plantain	*Alisma plantago-aquatica*		riparian/upland	RNWR/BIRA
Annual Jacob's ladder	*Polemonium micranthum*	X	upland/riparian	HS
Arroyo willow	*Salix lasiolepis*	X	riparian	HS
Arumleaf arrowhead	*Sagittaria cuneata*		riparian	RNWR
Awned flatsedge	*Cyperus aristatus*	X	riparian	HS
Baldhip rose	*Rosa gymnocarpa*		riparain/upland	RNWR
Balsam groundsel	*Senecio pauperculus*	X	riparian/upland	HS
Biennial cinquefoil	*Potentilla biennis*	X	riparian/upland	HS
Bitterdock	*Rumex obtusifolius*		riparian	JDP; RNWR
Black cottonwood	*Populus trichocarpa*	X	riparian	PRR; HS; MNR; BP; BB; RNWR/BIRA
Black hawthorn	*Crateagus douglasii*		riparian/upland	RNWR
Blackberry	*Rubus rubus*	X	disturbed areas	MNR; DP; BP
Blister buttercup	*Ranunculus sceleratus*		riparian/upland	RNWR
Blood currant	*Ribes sanguineum*		riparain/upland	RNWR
Blue forget-me-not	*Myosotis micrantha*	X	riparian/upland	HS
Bristly sedge	*Carex comosa*	X	riparian	PRR

Common Name	Scientific Name	General Location[a]	Habitat Type	Specific Location[b]
Brook cinquefoil	*Potentilla rivalis*	X	riparian/upland	HS
Buckhorn plantain	*Plantago lanceolata*	X	riparian/upland	HS; RNWR
Bugleweed	*Lycopus americanus*	X	riparian	MNR; DP; RNWR
Bunchberry	*Cornus canadensis*		riparian/upland	RNWR
Bushy cinquefoil	*Potentilla paradoxa*	X	riparian	HS
Buxbaum sedge	*Carex buxbaumii*	X	riparian	PRR
Cascade rockcress	*Arabis furcata*		riparain	
Celery-leaf buttercup	*Rannunculus sceleratus*	X	riparian/upland	HS
Chokecherry	*Prunus virginiana var. melanocarpa*	X	riparian	HS
Clustered dock	*Rumex conglomeratus*		riparian	RNWR
Clustered wildrose	*Rosa pisocarpa*		riparain/upland	RNWR
Columbia hawthorn	*Crataegus columbiana*	X	riparian	HS
Columbia milkvetch	*Astragalus columbianus*	X	upland shrub-steppe	PRR; HS
Columbia sedge	*Carex aperta*		riparian	RNWR/BIRA
Common burdock	*Arctium minus*		riparian	RNWR
Common cocklebur	*Xanthium strumareum*	X	riparian/upland	HS; RNWR
Common dogbane	*Apocynum cannabinum*	X	riparian	HS; MNR; DP; BP; RNWR
Common mare's-tail	*Hippuris vulgaris*		riparian	RNWR
Common plantain	*Plantago major*	X	riparian/upland	HS; RNWR
Corkscrew willow	*Salix matsudana*	X	riparian	HS
Coyote willow	*Salix exigua*	X	riparian	PRR; MNR; JDP
Creeping buttercup	*Ranunculus flammula*	X	riparian/upland	HS; RNWR/BIRA
Creeping eragrostis	*Eragrostis hypnoides*		riparian	RNWR/BIRA
Creeping loosestrife	*Lysimachia nummularia*		riparian	RNWR/BIRA
Curly dock	*Rumex crispus*	X	riparian	HS; MNR; JDP; DP; BP; RNWR
Cut-leaved water parsnip	*Berula erecta*	X	riparian	HS
Cutgrass	*Leersia oryzoides*		riparian	RNWR/BIRA
Dense sedge	*Carex densa*	X	riparian	PRR; HS; CWTDNWR
Dotted smartweed	*Polygonum punctatum*	X	riparian	MNR; RNWR
Douglas' sedge	*Carex douglasii*	X	riparian	HS
Dutch rush	*Equisetum hyemale var. affine*		riparian	RNWR
Evergreen blackberry	*Rubus laciniatus*		riparian	RNWR
False pimpernel	*Lindernia anagallidea*	X	riparian	PRR; HS
Field horsetail	*Equisetum arvense*	X	riparian	HS; RNWR
Flatsedge	*Cyperus cyperus*	X	riparian	MNR; BB
Fox sedge	*Carex vulpinoides*	X	riparian	MNR
Fringed waterplantain	*Damasonium californicum*		riparian/upland	
Geyer milkvetch	*Astragalus geyeri*	X	shoreline	PRR
Giant fawn-lily	*Erythronium oregonum*		riparian/upland	RNWR
Giant helleborine	*Epipactis gigantea*	X	shoreline	PRR;CWTDNWR
Golden currant	*Ribes aureum*	X	riparian/upland	HS
Green sedge	*Carex oederi*	X	riparian	MNR
Green-fruited sedge	*Carex interrupta*		riparian	RNWR/BIRA

Common Name	Scientific Name	General Location[a]	Habitat Type	Specific Location[b]
Greensheathed sedge	*Carex feta*	X	riparian	RNWR/BIRA
Hamblen desert-parsley	*Lomatium farinosum var. hambleniae*	X	shoreline	PRR
Hanging moss	*Antitrichia curtipendula*		riparian/upland	RNWR
Hawthorn	*Crataegus monogyna*		riparian/upland	RNWR
Heartweed	*Polygonum persicaria*	X	riparian	HS; RNWR
Henderson ricegrass	*Oryzopsis hendersonii*	X	shorline	PRR
Himalayan blackberry	*Rubus discolor*	X	riparian/disturbed sites	HS; BP; RNWR
Hoary aster	*Machaeranthera canescens*	X	riparian	HS; MNR
Hooded lady-tresses	*Spiranthes romanzoffiana*		riparian	RNWR
Hoover's desert parsley	*Lomatium tuberosum*	X	shoreline/upland	PRR; HS
Hoover's tauschia	*Tauschia hooveri*	X	shoreline	PRR
Hornwort	*Ceratophyllum demersum*		riparian	RNWR/BIRA
Howell's montia	*Montia howellii*		upland/riparian	
Howellia	*Howellia aquatilis*		riparian	RNWR/BIRA
Hudson Bay currant	*Ribes hudsonianum*	X	riparian/upland	MNR
Inflated sedge	*Carex vesicaria*	X	riparian	RNWR/BIRA
Japanese knotweed	*Polygonum cuspidatum*		riparian	RNWR
Kalm lobelia	*Lobelia kalmii*	X	riparian	PRR
Kellogg's sedge	*Carex lenticularis*	X	riparian	HS
Lindernia	*Lindernia dubia*		riparian	RNWR/BIRA
Longleaf phlox	*Phlox longifolia*	X	upland	HS; MNR
Loosestrife	*Lythrum portula*		riparian	RNWR/BIRA
Lyngbye's sedge	*Carex lyngbyei*		marsh	BB
Marsh horsetail	*Equisetum palustre*	X	riparian	BP; MNR
Meadow foxtail	*Alopcurus aequalis*		riparian	RNWR/BIRA
Medick milkvetch	*Astragalus speirocarpus*	X	shoreline/upland	PRR; HS
Mexican water-fern	*Azolla mexicana*		riparian	RNWR
Mockorange	*Philadelphus lewissii*		upland	RNWR
Nebraska sedge	*Carex nebrascensis*	X	riparian	MNR
Nootka rose	*Rosa nutkana*		riparian/upland	RNWR
Northern wormwood	*Artemisia campestris wormskioldii*		shoreline	HS
Norwegian cinquefoil	*Potentilla norvegica*	X	riparian/upland	HS
Obscure buttercup	*Ranunculus reconditus*	X	riparian/upland	PRR; DP
Pacific dogwood	*Cornus nuttallii*		riparian/upland	RNWR
Pacific silverweed	*Potentilla pacifica*		riparian/upland	RNWR
Pacific water-parsley	*Oenanthe sarmentosa*		riparian	RNWR
Pacific waterleaf	*Hydrophyllum tenuipes*		riparian	RNWR
Pacific willow	*Salix lasiandra*	X	riparian	MNR; JDP; DP; BP; BB
Peachleaf willow	*Salix amygdaloides*	X	riparian	PRR; HS; MNR; DP
Pennsylvania persicaria	*Polygonum pennsylvanicum*		riparian	RNWR
Pennyroyal	*Mentha pulegium*		riparian	RNWR
Plain'scottonwood	*Populus deltoides*	X	riparian	MNR; JDP; DP
Pond water-starwort	*Callitriche stagnalis*		riparian	RNWR

Common Name	Scientific Name	General Location[a]	Habitat Type	Specific Location[b]
Porcupine sedge	*Carex hystricina*	X	shoreline	PRR
Prairie sagebrush	*Artemisia ludoviciana*	X	riparian/upland	HS
Purple dragon-head	*Physostegia parviflora*		upland	RNWR
Purple loosestrife	*Lythrum salicaria*	X	riparian	HS
Pygmy-weed	*Crassula aquatica*		riparian	
Rabbitfoot grass	*Polypogon monspeliensis*	X	riparian	MNR; JDP
Red alder	*Alnus rubra*		islands/riparian/shoreline	BB; RNWR
Red columbine	*Aquilegia formosa*		riparian/upland	RNWR
Red-osier dogwood	*Cornus stolonifera*		riparian/sand-cobble substrate	DP; BP; BB; RNWR/BIRA
Reed canarygrass	*Phalaris arundinacea*	X	marsh	PRR; HS; MNR; BP; BB; RNWR/BIRA
Rigid willow	*Salix rigida*	X	riparian	MNR; RNWR
River willow	*Salix fluviatilis*	X	riparian/cobble-gravel substrate	PRR; MNR; JDP; DP; BP; BB; RNWR/BIRA
Robinson's onion	*Allium robinsonii*	X	shoreline/sand-rock substrate	PRR; HS
Rosy balsamroot	*Balsamorhiza rosea*	X	upland/shoreline	PRR; HS
Rough bugleweed	*Lycopus asper*	X	riparian	HS
Russian olive	*Elaeagnus angustifolia*	X	riparian; sand-cobble substrate	PRR; MNR; JDP; BP; BB
Salt eliotrope	*Heliotropium curassavicum*	X	riparian	MNR
Sandbar willow	*Salix exigua ssp. exigua*	X	riparian	HS
Scouler's willow	*Salix scouleriana*	X	riparian	HS
Sedgelike horsetail	*Equisetum scirpoides*		riparian	BP
Shining flatsedge	*Cyperus bipartatus*	X	riparian/sand	PRR; HS
Shore buttercup	*Ranunculus cymbalaria*	X	riparian/upland	HS
Siberian elm	*Ulmus pumila*	X	riparian/upland	HS
Silky northern wormwood	*Artemisia campestris borealis*	X	shoreline	PRR; HS; DP
Sitka spruce	*Picea sitchensis*		islands/riparian	BB
Skunk cabbage	*Lysichitum americanum*		riparian	RNWR
Slenderbeak sedge	*Carex athrostachya*	X	riparian	HS
Slimleaf onion	*Allium amplectens*	X	sand	PRR
Small forget-me-not	*Myosotis laxa*	X	riparian/upland	HS; MNR; RNWR/BIRA
Smallflowered buttercup	*Ranunculus abortivus*	X	riparian/upland	MNR
Smartweed	*Polygonum hydropiper*	X	riparian	HS; RNWR
Smooth scouringrush	*Equisetum laevigatum*	X	riparian	HS; MNR
Soft-leaved willow	*Salix sessilifolia*		riparian	RNWR/BIRA
Southern mugwort	*Limosella aquatica*	X	shoreline/sand	PRR; HS; RNWR/BIRA; CWTDNWR
Spatterdock	*Nuphar polysepalum*		riparian/upland	RNWR/BIRA
Spiked water-milfoil	*Myriophyllum spicatum*	X	riparian	HS
Squill onion	*Allium scilloides*	X	shoreline	PRR; HS
Stalked-pod milkvetch	*Astragalus sclerocarpus*	X	upland	PRR; HS
Sticky cinquefoil	*Potentilla glandulosa*		riparian/upland	RNWR

Common Name	Scientific Name	General Location[a]	Habitat Type	Specific Location[b]
Stinging nettle	*Urtica dioica*	X	riparian/upland	HS; BP; RNWR/BIRA
Straightbead buttercup	*Ranunculus orthorhynchus*		riparian/upland	RNWR
Straw-colored flatsedge	*Cyperus strigosus*	X	riparian	HS
Sweetbrier	*Rosa eglanteria*		riparain/upland	RNWR
Tansy ragwort	*Senecio jacobaea*		riparian/upland	RNWR
Tarragon	*Artemisia dracunculus*	X	riparian/upland	HS
Thompson's sandwort	*Arenaria franklinii thompsonii*	X	upland/sand	HS
Thread-stalk speedwell	*Veronica filiformis*		riparian	RNWR
Tooth-leaved monkey-flower	*Mimulus dentatus*		riparian	RNWR
Transparent milkvetch	*Astragalus diaphanus diaphanus*		upland/gravel substrate	
Violet suksdorfia	*Suksdorfia violacea*		upland/riparian	
Wapato	*Sagittaria latifolia*		riparian	RNWR/BIRA
Water birch	*Betula occidentalis*	X	riparian	HS
Water horsetail	*Equisetum fluviatile*		marsh	BB
Water lentil	*Lemna minor*		riparian	RNWR/BIRA
Water smartweed	*Polygonum coccineum*		riparian	RNWR
Water speedwell	*Veronica anagallis-aquatica*	X	riparian	HS; MNR
Water star-wort	*Callitriche heterophylla*		riparian	RNWR/BIRA
Water-pimpernel	*Samolus parviflorus*		riparian	
Water-purslane	*Ludwigia palustris*		riparian	RNWR/BIRA
Waterpepper	*Polygonum hydropiperoides*		riparian	RNWR/BIRA
Waterweed	*Eleodea canadensis*	X	riparian	HS; RNWR
Watson's willowherb	*Epilobium watsonii*	X	riparian	HS; RNWR
Western buttercup	*Ranunculus occidentalis*		riparian/upland	RNWR
Western dock	*Rumex occidentalis*	X	riparian	MNR
Western marsh aster	*Aster hesperius*	X	riparian	HS
Western scouringrush	*Equisetum hyemale*	X	riparian	PRR; HS; MNR; JDP; BP; BB
Western virgins-bower	*Clematis ligusticifolia*	X	riparian	HS
Whiplash willow	*Salix lasiandra*	X	riparian	HS; RNWR/BIRA
White eatonella	*Eatonella nivea*	X	shoreline/sand	PRR
White mulberry	*Morus alba*	X	riparian	HS; MNR; DP; BP
White water-buttercup	*Ranunculus aquatilis*	X	riparian/upland	RNWR/BIRA
Willow dock	*Rumex salicifolius triangulivalis*	X	riparian	HS
Willow weed	*Polygonum lapathifolium*	X	riparian	HS; MNR; JDP; DP; BP; BB
Wiry knotweed	*Polygonum majus*	X	riparian	MNR
Wood's rose	*Rosa woodsii*	X	riparian	HS; MNR; BB
Wool-grass	*Scirpus cyperinus*		riparian	RNWR/BIRA
Woolly mullein	*Verbascum thapsis*	X	riparian/upland	HS; RNWR
Woolly sedge	*Carex lanuginosa*	X	riparian	HS

Common Name	Scientific Name	General Location[a]	Habitat Type	Specific Location[b]
Yellow and blue forget-me-not	*Myosotis discolor*		riparian/upland	RNWR
Yellow flag	*Iris pseudocorus*		riparian	RNWR
Yellow monkey-flower	*Mimulus guttatus*	X	riparian	MNR; RNWR
Yellow salsify	*Tragopogon dubius*	X	riparian/upland	HS; MNR

a. X indicates species that occur within the study area; i.e., in or near the Columbia River between Priest Rapids Dam and McNary Dam.

b. Locations where distribution data were available:
BB = Below Bonneville Dam
BP = Bonneville pool
CRB/SOR = Columbia River backwater south of Richland
CSRC = Columbia River/Snake River confluence
CSRC-I = Columbia River/Snake River confluence islands
CWTDNWR = Columbian white-tailed deer National Wildlife Refuge
DP = Dalles pool
HR = Hanford Reach
HS = Hanford Site
JDP = John Day pool
LCNWR = Lewis and Clark National Wildlife Refuge
MNR = McNary Reservoir
PRR = Priest Rapids Reservoir
RNWR = Ridgefield National Refuge
RNWR/BIRA = Ridgefield National Wildlife Refuge Black Water Island Research Area
UNWR = Umatilla National Wildlife Refuge
WNWR = Willapa National Wildlife Refuge

c. Common names were not available for these caddisflies.

Appendix B

Tier I Species List for the Screening Assessment of Ecological Risk from the Columbia River

Appendix B

Tier I Species List for the Screening Assessment of Ecological Risk from the Columbia River

Species[a]	Screening Criteria Used by Panel[b]						Total Responses		Species Selected by the CRCIA Team[c]
	Commercially/ Recreationally Significant	Federal/ State Protected	Key Predator/ Prey	High Potential Exposure	Available Toxicological Benchmarks	Representative of Food Chain Level or Foraging Guild	Total Number of "No" Responses	Total Number of "Yes" Responses	
Algae									
Achnanthes spp.	N	N	Y	Y	Y	N	3	3	NPT, CTUIR
Asterionella spp.	N	N	Y	Y	Y	Y	2	4	NPT, CTUIR
Chlorophyta spp.	N	N	Y	Y	Y	N	3	3	NPT, CTUIR
Cladophora spp.	N	N	Y	Y	Y	N	3	3	NPT, CTUIR
Cocconeis spp.	N	N	Y	Y	Y	N	3	3	NPT, CTUIR
Cyclotella spp.	N	N	Y	Y	Y	N	3	3	NPT, CTUIR
Fragilaria spp.	N	N	Y	Y	Y	Y	2	4	NPT, CTUIR
Gomphonema spp.	N	N	Y	Y	Y	N	3	3	NPT, CTUIR
Melosira spp.	N	N	Y	Y	Y	Y	2	4	NPT, CTUIR
Nitzchia spp.	N	N	Y	Y	Y	N	3	3	NPT, CTUIR
Stephanodiscus spp.	N	N	Y	Y	Y	N	3	3	NPT, CTUIR
Stigeoclonium spp.	N	N	Y	Y	Y	N	3	3	NPT, CTUIR
Amphibians									
Bullfrog	Y	N	N	Y	Y	Y	2	4	
Great Basin spadefoot									CTUIR, ERC
Spotted frog	N	Y	Y	Y	N	Y	2	4	
Woodhouse toad									NPT
Aquatic Invertebrates									
Caddisfly (all)	N	N	Y	Y	Y	N	3	3	CTUIR, NPT, WDOE
California floater	Y	Y	N	Y	Y	Y	1	5	YIN
Clams (all)									YIN
Columbia pebblesnail	N	Y	Y	Y	N	Y	2	4	
Crayfish	Y	N	Y	Y	Y	Y	1	5	CTUIR, NPT
Crustaceans (all)									CTUIR
Cyclops	N	N	Y	Y	Y	Y	2	4	CTUIR, WDOE
Diaptomus	N	N	Y	Y	Y	Y	2	4	CTUIR, WDOE
Fresh water shrimp (*Hyalella* spp.)									CTUIR, WDOE, YIN
Mayflies (all)									CTUIR
Midge	N	N	Y	Y	Y	Y	2	4	
Mussels (all)									CTUIR, NPT, YIN
Shortface lanx	N	Y	Y	Y	N	Y	2	4	
Stoneflies (all)									CTUIR, WDOE, YIN
Water flea	N	N	Y	Y	Y	Y	2	4	CTUIR, WDOE

Species[a]	Screening Criteria Used by Panel[b]						Total Responses		Species Selected by the CRCIA Team[c]
	Commercially/ Recreationally Significant	Federal/ State Protected	Key Predator/ Prey	High Potential Exposure	Available Toxicological Benchmarks	Representative of Food Chain Level or Foraging Guild	Total Number of "No" Responses	Total Number of "Yes" Responses	
Birds									
American coot	N	N	Y	Y	Y	Y	2	4	NPT, CTUIR
American kestrel									NPT
American white pelican	N	Y	Y	Y	Y	N	2	4	NPT, CTUIR
American wigeon	Y	N	N	Y	Y	N	3	3	
Avocet									CTUIR
Bald eagle	Y	Y	Y	Y	Y	Y	0	6	CTUIR, NPT
Barn owl									NPT
Belted kingfisher	N	N	Y	Y	N	Y	3	3	CTUIR, NPT
Black-billed magpie									CTUIR
Black-crowned night heron									ERC
Blue-winged teal	Y	N	N	Y	N	Y	3	3	
Bufflehead	Y	N	Y	N	Y	Y	2	4	
Burrowing owl									CTUIR
California quail	Y	N	N	N	Y	Y	3	3	CTUIR, NPT
Canada goose									CTUIR, ERC, NPT, YIN
Caspian tern	N	N	Y	Y	N	Y	3	3	
Chukar	Y	N	Y	N	N	Y	3	3	
Cinnamon teal	Y	N	N	Y	Y	N	3	3	
Common crow									CTUIR
Common goldeneye	Y	N	Y	N	Y	Y	2	4	
Common merganser	Y	N	Y	Y	N	N	3	3	CTUIR, NPT
Common raven									CTUIR
Common snipe									WDFW
Double-crested cormorant									CTUIR, ERC
Eared grebe	N	N	N	Y	Y	Y	3	3	CTUIR
Eurasian wigeon	Y	N	N	Y	N	Y	3	3	
Forster's tern	N	N	Y	Y	N	Y	3	3	NPT
Gadwall	Y	N	N	Y	Y	N	3	3	
Great blue heron	N	N	Y	Y	Y	Y	2	4	CTUIR, NPT
Green-winged teal	Y	N	N	Y	Y	Y	2	4	
Gulls (all)									ERC
Hawks (all)									CTUIR
Hooded merganser	Y	N	Y	Y	N	N	3	3	
Lesser scaup	Y	N	Y	N	Y	Y	2	4	
Mallard	Y	N	N	Y	Y	Y	2	4	CTUIR, NPT
Marsh wren									WDFW
Northern pintail	Y	N	N	Y	Y	N	3	3	
Northern shoveler	Y	N	N	Y	Y	Y	2	4	
Osprey	N	N	Y	Y	Y	N	3	3	CTUIR, NPT
Pied-billed grebe									NPT
Red-breasted merganser	Y	N	Y	Y	N	N	3	3	
Red-winged blackbird	N	N	Y	N	Y	Y	3	3	NPT
Ring-necked pheasant									CTUIR
Sandhill crane	N	Y	N	N	Y	Y	3	3	

Species[a]	Screening Criteria Used by Panel[b]						Total Responses		Species Selected by the CRCIA Team[c]
	Commercially/ Recreationally Significant	Federal/ State Protected	Key Predator/ Prey	High Potential Exposure	Available Toxicological Benchmarks	Representative of Food Chain Level or Foraging Guild	Total Number of "No" Responses	Total Number of "Yes" Responses	
Snow goose	N	N	N	Y	Y	Y	3	3	
Swallows (all)									CTUIR, EPA, ERC, NPT
Turkey vulture									CTUIR
Virginia rail									WDFW
Emergent Vegetation									
Alkali bulrush	Y	N	Y	Y	N	N	3	3	CTUIR, NPT
Baltic rush	Y	N	Y	Y	N	Y	2	4	CTUIR, NPT
Columbia yellow cress	Y	N	Y	Y	N	Y	2	4	YIN, CTUIR
Common cattail	Y	N	N	Y	Y	Y	2	4	CTUIR, NPT
Common spikerush	Y	N	Y	Y	N	Y	2	4	NPT
Hardstem bulrush	Y	N	Y	Y	N	Y	2	4	CTUIR, NPT
Rushes (all)									CTUIR, NPT
Softstem bulrush	Y	N	Y	Y	N	N	3	3	CTUIR, NPT, YIN
Three-square bulrush	Y	N	Y	Y	N	N	3	3	CTUIR, NPT
Fish									
Bull trout	Y	Y	Y	N	N	N	3	3	
Channel catfish	Y	N	Y	Y	Y	Y	1	5	CTUIR
Common carp	Y	N	Y	Y	N	N	3	3	CTUIR, NPT
Fall chinook salmon	Y	Y	Y	Y	Y	Y	0	6	CTUIR, NPT
Fathead minnow									CTUIR
Largemouth bass									CTUIR, ERC
Largescale sucker									NPT, WDFW
Mountain sucker	N	Y	N	Y	N	Y	3	3	NPT, WDFW
Mountain whitefish	Y	N	Y	Y	Y	N	2	4	CTUIR, NPT
Northern squawfish	N	N	Y	Y	Y	N	3	3	NPT
Pacific lamprey	Y	N	N	Y	N	Y	3	3	CTUIR
Paiute sculpin									WDFW
Prickly sculpin	N	N	Y	Y	N	Y	3	3	
Rainbow trout	Y	N	Y	N	Y	Y	2	4	CTUIR
Redside shiner	N	N	Y	Y	Y	Y	2	4	
Sandroller									WDFW
Smallmouth bass	Y	N	Y	Y	N	Y	2	4	CTUIR, ERC
Sockeye salmon	Y	Y	N	N	Y	N	3	3	CTUIR
Spring chinook salmon	Y	Y	N	N	Y	N	3	3	CTUIR, NPT
Steelhead trout	Y	N	Y	N	Y	Y	2	4	CTUIR, NPT
Summer chinook salmon	Y	Y	N	N	N	Y	3	3	
Threespine stickleback									WDFW
Walleye									ERC
White sturgeon	Y	N	Y	Y	Y	N	2	4	CTUIR
Fungi[d]									CTUIR
Macrophytes									
Duckweed	N	N	Y	Y	Y	Y	2	4	CTUIR
Pondweed	N	N	Y	Y	Y	Y	2	4	CTUIR
Water milfoil	N	N	Y	Y	Y	Y	2	4	CTUIR, EPA
Waterweed	N	N	Y	Y	Y	Y	2	4	CTUIR

Species[a]	Screening Criteria Used by Panel[b]						Total Responses		Species Selected by the CRCIA Team[c]
	Commercially/ Recreationally Significant	Federal/ State Protected	Key Predator/ Prey	High Potential Exposure	Available Toxicological Benchmarks	Representative of Food Chain Level or Foraging Guild	Total Number of "No" Responses	Total Number of "Yes" Responses	
Mammals									
Badger									CTUIR
Bats (all)									CTUIR
Beaver	Y	N	Y	Y	N	N	3	3	
Black-tailed jackrabbit									CTUIR
Bobcat									WDFW, YIN
Cottontail rabbit									CTUIR
Coyote									CTUIR, NPT, YIN
Deer mouse	N	N	Y	Y	Y	Y	2	4	CTUIR, NPT
House mouse	N	N	N	Y	Y	Y	3	3	CTUIR, NPT
Mice (all)									CTUIR, NPT
Mink	Y	N	Y	N	Y	Y	2	4	
Mule deer									CTUIR, ERC, NPT, WDFW
Muskrat	N	N	Y	Y	Y	Y	2	4	NPT
Porcupine									YIN
Raccoon									CTUIR, ERC
River otter	N	N	Y	Y	Y	Y	2	4	
Roosevelt elk	Y	N	Y	Y	Y	Y	1	5	
Striped skunk									ERC, YIN
Weasel (all)									CTUIR, WDFW
Western harvest mouse	N	N	Y	Y	Y	Y	2	4	CTUIR, NPT
White-tailed deer	Y	N	Y	Y	Y	Y	1	5	
Reptiles									
Bull snake									CTUIR, YIN
Lizards (all)									CTUIR
Turtles (all)									CTUIR, YIN
Water snake									WDOE, YIN
Western diamondback rattlesnake									CTUIR, YIN
Western garter snake									ERC, YIN
Whip snake									CTUIR, YIN
Terrestrial Invertebrates									
Ants (all)									CTUIR
Beetles (all)									CTUIR
Butterflies and moths (all)									CTUIR
Dragonflies(all)									CTUIR
Earthworms (all)									CTUIR, YIN
Millepedes (all)									CTUIR
Sowbugs									CTUIR
Terrestrial Vegetation									
Big sagebrush									CTUIR
Black cottonwood	N	N	Y	N	Y	Y	3	3	CTUIR
Black locust									CTUIR
Cheatgrass									CTUIR
Chokecherry									YIN
Columbia milkvetch									YIN

Species[a]	Screening Criteria Used by Panel[b]						Total Responses		Species Selected by the CRCIA Team[c]
	Commercially/ Recreationally Significant	Federal/ State Protected	Key Predator/ Prey	High Potential Exposure	Available Toxicological Benchmarks	Representative of Food Chain Level or Foraging Guild	Total Number of "No" Responses	Total Number of "Yes" Responses	
Common dogbane									CTUIR
Common witchgrass									CTUIR
Coyote willow									CTUIR
Crack willow									CTUIR
Currant									YIN
Dense sedge									CTUIR, YIN
False pimpernel									YIN
Ferns									EPA
Fox sedge	Y	N	Y	Y	N	Y	2	4	
Large barnyard grass									CTUIR
Little buttercup	Y	N	Y	Y	N	Y	2	4	
Mulberry									ERC, YIN
Rabbit brush									CTUIR
Reed canary grass									CTUIR, NPT
Russian thistle									CTUIR
Shining flatsedge									CTUIR, YIN
Silky northern wormwood									YIN
Southern mudwort									YIN
Tumble mustard									CTUIR
Weeping willow									CTUIR
Wild onions (all)									CTUIR, ERC
Willow									EPA, ERC, YIN
Yellow bell									CTUIR

a. Not all Tier I species in Appendix B appear individually in Appendix C as some species were grouped based on similar life style and foraging strategy before they were assigned scores.

b. Empty cells denote those species selected by the CRCIA Team. Cells with "Y," "N," and numeric values denote those species screened by the panel of regional biologists; some of the panel's species were also selected by the CRCIA Team.

c. CRCIA Team abbreviations:
CTUIR = Confederated Tribes of the Umatilla Indian Reservation
EPA = U.S. Environmental Protection Agency
ERC = Environmental Restoration Contract Team
NPT = Nez Perce Tribe
WDFW = Washington Department of Fish and Wildlife
WDOE = Washington Department of Ecology
YIN = Yakima Indian Nation.

d. The CRCIA Team added fungi as a broad taxon rather than adding individual species of fungi.

Appendix C

Scoring of Tier I Species for the Screening Assessment of Ecological Risk from the Columbia River

Appendix C

Scoring of Tier I Species for the Screening Assessment of Ecological Risk from the Columbia River

Of the 181 Tier I species, some were grouped based on similar life styles and foraging strategies resulting in 120 species. The CRCIA Team added 5 species to the 120 for a total of 125 species. These 125 species were scored as described in the footnotes.

Footnotes for Appendix C

a. Rows that are not shaded contain individual scores, except rows 26 and 32 which contain ranks. Shaded rows contain summary scores. Biomag. = biomagnifying contaminants; Nonbiomag. = non-biomagnifying contaminants. Explanation of summary scores:
   row 1 = summation of rows 3 and 5
   row 2 = summation of rows 4 and 5
   row 9 = summation of rows 10, 11, and 12
   row 14 = summation of rows 1, 9, and 13
   row 15 = summation of rows 2, 9, and 13
   row 17 = multiplication of media weightings for in-river source areas from Table 3.13 with rows 3, 6, 7, 8, 10, 11, 12, and 13 followed by summation of these rows
   row 18 = multiplication of media weightings for in-river source areas from Table 3.13 with rows 4, 6, 7, 8, 10, 11, 12, and 13 followed by summation of these rows
   row 20 = multiplication of media weightings for outfalls from Table 3.13 with rows 3, 6, 7, 8, 10, 11, 12, and 13 followed by summation of these rows
   row 21 = multiplication of media weightings for outfalls from Table 3.13 with rows 4, 6, 7, 8, 10, 11, 12, and 13 followed by summation of these rows
   row 23 = average of rows 17 and 18
   row 24 = average of rows 20 and 21
   row 25 = average of rows 23 and 24
   row 31 = summation of rows 28 and 29 with the quotient of row 25 divided by 10. A verbal explanation of summary scores is provided in Section 3.2.11.
b. Species added by the CRCIA Team.
c. Ranks of grand average exposure scores. Ranks were assigned within taxonomic groups.
d. Ranks of composite effect scores. Ranks were assigned within taxonomic groups.
e. Species that occur primarily in upland areas outside the riparian zone. These species were eliminated from further consideration in the selection of Tier II receptor species (see Section 3.2.12).

Row[a]	Exposure Pathways/Media/Source Areas	Algae: Periphyton	Algae: Phytoplankton	Amphibians: Bullfrog	Amphibians: Spadefoot toad	Amphibians: Woodhouse's toad	Aquatic Invertebrates: Caddisfly	Aquatic Invertebrates: Clams/mussels/snails	Aquatic Invertebrates: Crayfish	Aquatic Invertebrates: Dragonfly[b]	Aquatic Invertebrates: Fresh water shrimp	Aquatic Invertebrates: Mayfly	Aquatic Invertebrates: Midge	Aquatic Invertebrates: Stonefly	Aquatic Invertebrates: Water flea	Aquatic Invertebrates: Worms (oligochaetes)[b]
1	Ingestion (overall) - biomag.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2	Ingestion (overall) - nonbiomag.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3	Ingestion (biotic, i.e. prey) - biomag.	1	1	3	3	3	2	2	2	2	2	2	2	2	2	2
4	Ingestion (biotic, i.e. prey) - nonbiomag.	4	4	2	2	2	3	3	3	3	3	3	3	3	3	3
5	Ingestion (abiotic)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
6	Sediment/Soil	0	0	2	1	1	4	4	4	4	4	4	4	4	0	4
7	Groundwater/Pore Water	0	0	2	1	1	4	4	4	4	4	4	4	4	0	4
8	Surface Water	0	0	4	4	4	4	4	4	4	4	4	4	4	4	4
9	Dermal	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
10	Sediment/soil	4	2	3	2	2	4	4	4	4	4	4	4	4	0	4
11	Groundwater/Pore Water	4	0	3	2	2	4	4	4	4	4	4	4	4	0	4
12	Surface Water	4	4	4	3	3	4	4	4	4	4	4	4	4	4	4
13	Inhalation	0	0	3	3	3	0	0	0	0	0	0	0	0	0	0
14	Total - biomag.	[illegible]	7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
15	Total - nonbiomag.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
16																
17	In-River Total - biomag.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
18	In-River Total - nonbiomag.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
19																
20	Outfall Total - biomag.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
21	Outfall Total - nonbiomag.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
22																
23	In-River Average	[illegible]	13	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
24	Outfall Average	21	13	34	27	27	37	37	37	37	37	37	37	37	[illegible]	37
25	Grand Average Exposure	23	13	[illegible]	[illegible]	25.5	41	41	41	41	41	41	41	41	[illegible]	41
26	Exposure Rank[c]	1	2	1	2	2	1	1	1	1	1	1	1	1	10	1
27																
28	Exposure Duration	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
29	Sensitivity	1	1	3	3	3	1	1	1	1	1	1	1	1	1	1
30																
31	Composite Effect Score	7.3	8.3	10.36	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
32	Composite Rank[d]	1	2	1	1	1	1	1	1	1	1	1	1	1	10	1

Row[a]	Exposure Pathways/Media/Source Areas	Birds: American coot	Birds: American kestrel	Birds: American white pelican	Birds: Avocet	Birds: Bald eagle	Birds: Barn owl	Birds: Belted kingfisher	Birds: Black-billed magpie	Birds: Black-crowned night heron	Birds: Burrowing owl	Birds: California quail	Birds: Cliff swallow	Birds: Common merganser	Birds: Common snipe	Birds: Crow/Raven[b]	Birds: Dabbling ducks (e.g., wigeon)	Birds: Diving ducks (e.g., bufflehead)	Birds: Double-crested cormorant	Birds: Forster's tern
1	Ingestion (overall) - biomag.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2	Ingestion (overall) - nonbiomag.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3	Ingestion (biotic, i.e. prey) - biomag.	3	4	4	4	4	4	4	3	4	4	2	4	4	4	3	3	4	4	3
4	Ingestion (biotic, i.e. prey) - nonbiomag.	2	1	1	1	1	1	1	2	1	1	3	1	1	1	2	2	1	1	2
5	Ingestion (abiotic)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
6	Sediment/Soil	4	0	2	4	0	0	0	0	4	0	2	2	2	4	0	4	2	2	2
7	Groundwater/Pore Water	4	0	0	2	0	0	0	0	2	0	0	0	0	2	0	4	2	0	0
8	Surface Water	4	2	4	4	4	2	4	2	4	2	2	2	4	4	2	4	4	4	4
9	Dermal	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
10	Sediment/soil	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
11	Groundwater/Pore Water	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	Surface Water	2	0	2	2	1	0	2	0	2	0	0	1	2	2	0	2	2	2	2
13	Inhalation	3	1	3	3	1	1	1	2	2	3	3	1	3	3	2	3	3	3	3
14	Total - biomag.	[illegible]	[illegible]	17	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	17	21	[illegible]	22	[illegible]	[illegible]	[illegible]
15	Total - nonbiomag.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
16																				
17	In-River Total - biomag.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
18	In-River Total - nonbiomag.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
19																				
20	Outfall Total - biomag.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
21	Outfall Total - nonbiomag.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
22																				
23	In-River Average	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
24	Outfall Average	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	17	21	[illegible]	[illegible]	21	[illegible]	[illegible]	27	[illegible]	[illegible]
25	Grand Average Exposure	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	22
26	Exposure Rank[c]	1	29	11	3	24	29	22	28	6	26	17	21	11	3	26	1	7	11	11
27																				
28	Exposure Duration	4	4	4	2	2	4	2	4	4	2	4	2	2	4	4	2	2	4	2
29	Sensitivity	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
30																				
31	Composite Effect Score	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
32	Composite Rank[d]	1	16	7	10	28	16	28	13	4	29	11	25	21	2	13	16	28	7	21

Row[a]	Exposure Pathways/Media/Source Areas	Birds: Goose/Mallard	Great blue heron	Gulls	Marsh wren	Northern harrier	Osprey	Pied-billed grebe	Red-winged blackbird	Ring-necked pheasant	Sandhill crane	Turkey vulture	Virginia rail	Emergent Vegetation: Columbia yellowcress	Common cattail	Rush (all)
1	Ingestion (overall) - biomag.	8	12	9	7	6	8	10	7	6	12	9	13	9	9	9
2	Ingestion (overall) - nonbiomag.	9	[illegible]	8	[illegible]	[illegible]	[illegible]	7	[illegible]	7	[illegible]	[illegible]	14	11	13	13
3	Ingestion (biotic, i.e. prey) - biomag.	2	4	3	3	4	4	4	3	2	4	4	3	1	1	1
4	Ingestion (biotic, i.e. prey) - nonbiomag.	3	1	2	2	1	1	1	2	3	1	1	2	4	4	4
5	Ingestion (abiotic)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
6	Sediment/Soil	4	2	2	2	0	0	2	2	2	2	0	4	4	4	4
7	Groundwater/Pore Water	0	2	0	0	0	0	0	0	0	2	0	2	4	4	4
8	Surface Water	2	4	4	2	2	4	4	2	2	4	2	4	0	0	0
9	Dermal	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
10	Sediment/soil	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
11	Groundwater/Pore Water	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	Surface Water	2	2	2	1	0	2	2	1	0	1	0	2	4	4	4
13	Inhalation	3	2	3	2	2	1	3	2	3	2	1	3	0	0	0
14	Total - biomag.	15	18	15	12	10	16	17	12	11	17	8	20	15	15	15
15	Total - nonbiomag.	15	15	16	11	7	10	14	11	12	14	[illegible]	16	18	18	18
16																
17	In-River Total - biomag.	20	24	30	17	16	19	22	17	16	26	14	28	26	26	26
18	In-River Total - nonbiomag.	22	20	16	15	[illegible]	12	16	15	16	15	[illegible]	26	32	32	28
19																
20	Outfall Total - biomag.	26	28	26	21	19	20	26	21	20	27	18	28	22	22	22
21	Outfall Total - nonbiomag.	28	22	24	19	18	16	22	16	22	21	19	20	28	28	28
22																
23	In-River Average	21	23	19	16	16	15	19	16	15	22	11	27	29	30	29
24	Outfall Average	27	25	25	20	15	17	25	20	21	24	14	31	25	25	25
25	Grand Average Exposure	24	24	22	16	13	15	22	16	16	23	12	29	27	27	27
26	Exposure Rank[c]	8	8	11	17	26	22	11	17	17	10	29	3	1	1	1
27																
28	Exposure Duration	4	4	4	2	4	2	4	2	4	1	1	4	4	4	4
29	Sensitivity	4	4	4	4	4	4	4	4	4	4	4	4	2	2	2
30																
31	Composite Effect Score	10.4	10.4	10.2	7.6	8.8	7.5	10.2	7.6	[illegible]	7.3	6.2	10.9	8.7	8.7	8.7
32	Composite Rank[d]	5	5	7	23	13	26	7	23	11	30	31	2	1	1	1

Row[a]	Exposure Pathways/Media/Source Areas	Fish: Bass (e.g., largemouth and smallmouth)	Carp	Channel catfish	Fathead minnow	Largescale sucker	Mountain sucker	Mountain whitefish	Pacific lamprey	Paiute sculpin	Salmon (all)	Sand roller	Shiner	Squawfish	Steelhead trout	Threespine stickleback	Trout (bull and rainbow)	Walleye	White sturgeon	Fungi: Fungi
1	Ingestion (overall) - biomag.	13	13	16	11	14	14	11	10	10	10	13	11	13	8	11	10	12	14	8
2	Ingestion (overall) - nonbiomag.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3	Ingestion (biotic, i.e. prey) - biomag.	4	3	3	3	2	2	3	2	3	4	3	3	4	4	3	4	4	4	1
4	Ingestion (biotic, i.e. prey) - nonbiomag.	1	2	2	2	3	3	2	3	2	1	2	2	1	1	2	1	1	1	4
5	Ingestion (abiotic)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
6	Sediment/Soil	2	3	4	2	4	4	2	2	3	1	3	2	2	0	2	1	2	3	4
7	Groundwater/Pore Water	2	3	4	2	4	4	2	2	3	1	3	2	2	0	2	1	2	3	0
8	Surface Water	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	0
9	Dermal	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
10	Sediment/soil	1	2	4	2	3	3	3	2	3	2	3	2	1	0	1	2	1	2	2
11	Groundwater/Pore Water	1	2	4	2	3	3	3	2	3	2	3	2	1	0	1	2	1	2	0
12	Surface Water	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	0
13	Inhalation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	Total - biomag.	18	21	27	18	24	24	21	18	24	18	23	18	18	12	17	18	18	22	7
15	Total - nonbiomag.	15	20	26	[illegible]	[illegible]	[illegible]	20	[illegible]	23	15	23	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	15	[illegible]	10
16																				
17	In-River Total - biomag.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	14
18	In-River Total - nonbiomag.	22	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	20
19																				
20	Outfall Total - biomag.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	14
21	Outfall Total - nonbiomag.	19	27	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	20
22																				
23	In-River Average	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	17
24	Outfall Average	22	26	27	25	34	34	26	25	31	22	31	26	[illegible]	19	22	[illegible]	22	26	17
25	Grand Average Exposure	23.5	20.5	[illegible]	[illegible]	27.5	27.5	20.5	27	[illegible]	23.5	[illegible]	27	23.5	[illegible]	23.5	23.5	23.5	20.5	17
26	Exposure Rank[c]	12	6	1	9	2	2	6	9	4	12	4	9	12	18	12	12	12	6	1
27																				
28	Exposure Duration	4	4	4	4	4	4	4	2	4	2	4	4	4	2	4	4	4	4	4
29	Sensitivity	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2
30																				
31	Composite Effect Score	9.36	10.06	11.1	8.7	10.72	10.72	10.06	7.7	9.64	7.36	10.4	9.7	9.36	[illegible]	9.36	9.36	9.36	10.05	[illegible]
32	Composite Rank[d]	11	6	1	9	2	2	6	16	4	17	4	9	11	18	11	11	11	6	1

Row[a]	Exposure Pathways/Media/Source Areas	Macrophytes			Mammals																								Reptiles						Terrestrial Invertebrates					
		Duckweed	Watercress[b]	Water milfoil	Badger	Bat (all)	Beaver	Black-tailed jackrabbit	Bobcat	Cottontail rabbit	Coyote	Deer mouse	Great Basin pocket mouse[b]	Mink	Mule deer	Muskrat	Porcupine	Raccoon	River otter	Striped skunk	Weasel	Western harvest mouse	Bull snake	Lizards	Western diamondback rattlesnake	Western garter snake	Western painted turtle	Whip snake	Ants	Beetles	Butterflies and moths	Earthworms	Millipedes	Sowbugs
1	Ingestion (overall) - biomag.																																							
2	Ingestion (overall) - nonbiomag.																																							
3	Ingestion (biotic, i.e. prey) - biomag.	1	1	1	4	4	2	2	4	2	3	2	2	4	2	2	2	3	4	3	4	3	4	3	4	3	3	4	3	3	2	3	3	3
4	Ingestion (biotic, i.e. prey) - nonbiomag.	4	4	4	1	1	3	3	1	3	2	3	3	1	3	3	3	2	1	2	1	2	1	2	1	2	2	1	2	2	3	2	2	2
5	Ingestion (abiotic)																																							
6	Sediment/Soil	0	4	4	2	0	2	2	2	2	2	2	2	0	2	2	2	2	2	2	2	2	1	1	1	1	1	1	4	4	0	4	4	4
7	Groundwater/Pore Water	0	4	4	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	0	0	0
8	Surface Water	0	0	0	2	2	2	2	2	2	2	2	2	2	2	2	4	2	2	2	2	2	0	0	0	4	4	0	0	0	0	0	0	0
9	Dermal																																							
10	Sediment/soil	2	2	2	2	0	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	4	4	0	4	4	4
11	Groundwater/Pore Water	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	Surface Water	4	4	4	0	0	2	0	0	0	2	0	0	2	2	2	0	2	2	2	0	0	0	0	0	2	2	0	0	0	0	0	0	0
13	Inhalation	0	0	0	3	1	3	3	3	3	3	3	3	3	3	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
14	Total - biomag.	7	9	10	10	7	10	11	10	11	14	11	11	12	13	12	11	14	17	14	19	15	20	9	10	16	14	16	16	16	7	14	14	14
15	Total - nonbiomag.	12	14	14	10	4	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
16																																								
17	In-River Total - biomag.	10	13	14	14	11	14	14	14	14	16	14	14	16	17	16	15	18	21	18	23	19	24	13	14	20	18	20	20	20	11	18	18	18
18	In-River Total - nonbiomag.	16	18	18	14	8	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14
19																																								
20	Outfall Total - biomag.	10	13	14	14	11	14	14	14	14	16	14	14	16	17	16	15	18	21	18	23	19	24	13	14	20	18	20	20	20	11	18	18	18
21	Outfall Total - nonbiomag.	16	18	18	14	8	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14
22																																								
23	In-River Average	13	16	16	12	9	12	12	12	12	15	12	12	14	15	14	13	16	18	16	21	17	22	13	14	18	16	18	18	18	9	16	16	16
24	Outfall Average	13	15	16	12	9	12	12	12	12	15	12	12	15	16	15	13	16	18	16	21	17	22	13	14	18	16	18	18	18	9	16	16	16
25	Grand Average Exposure	13	17	17	12	9	12	12	12	12	15	12	12	15	16	15	13	16	18	16	21	17	22	13	14	18	16	18	18	18	9	16	16	16
26	Exposure Rank[c]	3	1	1	8	18	3	8	8	8	3	8	8	17	7	1	8	3	2	3	8	8	3	3	3	1	1	3	1	1	8	3	3	3
27																																								
28	Exposure Duration	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
29	Sensitivity	1	2	2	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3	3	3	1	1	1	1	1	1
30																																								
31	Composite Effect Score	63	87	87	58	44	61	58	58	58	73	58	58	73	78	73	63	78	88	78	103	83	108	63	68	88	78	88	88	88	43	78	78	78
32	Composite Rank[d]	3	1	1	8	18	3	8	8	8	3	8	8	17	7	1	8	3	2	3	8	8	3	3	3	1	1	3	1	1	8	3	3	3

Row[a]	Exposure Pathways/Media/Source Areas	Terrestrial Vegetation																								
		Big sage[e]	Black cottonwood	Black locust	Cheatgrass[e]	Chokecherry	Columbia milkvetch[e]	Common dogbane	Common wildgrass	Current	Dense sedge	False pimpernel	Fems	Large barnyard grass	Mulberry	Rabbitbrush[e]	Reed canarygrass	Russian thistle[e]	Shining fleabane	Silky northern wormwood	Southern mudwort	Tumble mustard[e]	Wild onion	Willow (all)	Yellow bell
1	Ingestion (overall) - biomag.	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
2	Ingestion (overall) - nonbiomag.	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13
3	Ingestion (biotic, i.e. prey) - biomag.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
4	Ingestion (biotic, i.e. prey) - nonbiomag.	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
5	Ingestion (abiotic)	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
6	Sediment/Soil	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
7	Groundwater/Pore Water	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
8	Surface Water	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	Dermal	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
10	Sediment/soil	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
11	Groundwater/Pore Water	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	Surface Water	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
13	Inhalation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	Total - biomag.	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13
15	Total - nonbiomag.	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17
16																										
17	In-River Total - biomag.	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
18	In-River Total - nonbiomag.	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
19																										
20	Outfall Total - biomag.	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
21	Outfall Total - nonbiomag.	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
22																										
23	In-River Average	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27
24	Outfall Average	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27
25	Grand Average Exposure	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
26	Exposure Rank[c]	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
27																										
28	Exposure Duration	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
29	Sensitivity	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
30																										
31	Composite Effect Score	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
32	Composite Rank[d]	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

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